

WIRED

UK Edition

IDEAS | TECHNOLOGY

DESIGN | BUSINESS

Essential

**GEAR
WE LOVE**

20 pages of
WIRED's
favourite kit

**184-page
double
issue**

**GET AN
EDGE** with
TEAM SKY
**SERENA
WILLIAMS**
RED BULL
MERCEDES
TEAM GB

What you can learn
from the world's
best performers

JUL / AUG 16
WIRED.CO.UK

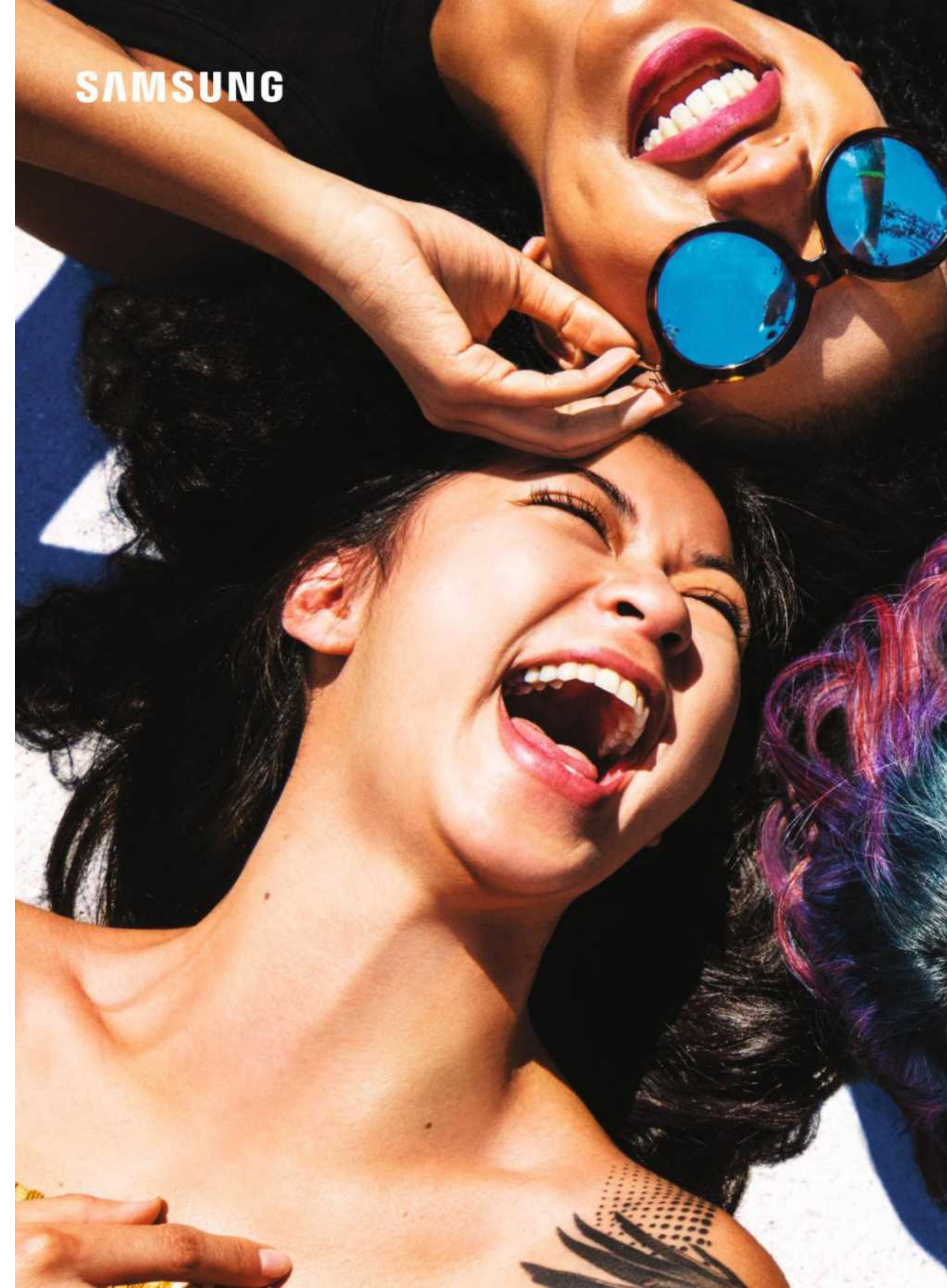
**KEVIN
KELLY** on
**THE NEW
CREATIVITY**

**The science
of winning**

✦ Chris Froome goes on
the attack for WIRED



SAMSUNG



Galaxy S7 edge | Gear 360



P5 Wireless.
We've taken
away the wires
but kept the
sound quality.



£329.99

from authorised retailers

Buy direct from bowers-wilkins.co.uk/P5W

Two-year warranty

Free delivery

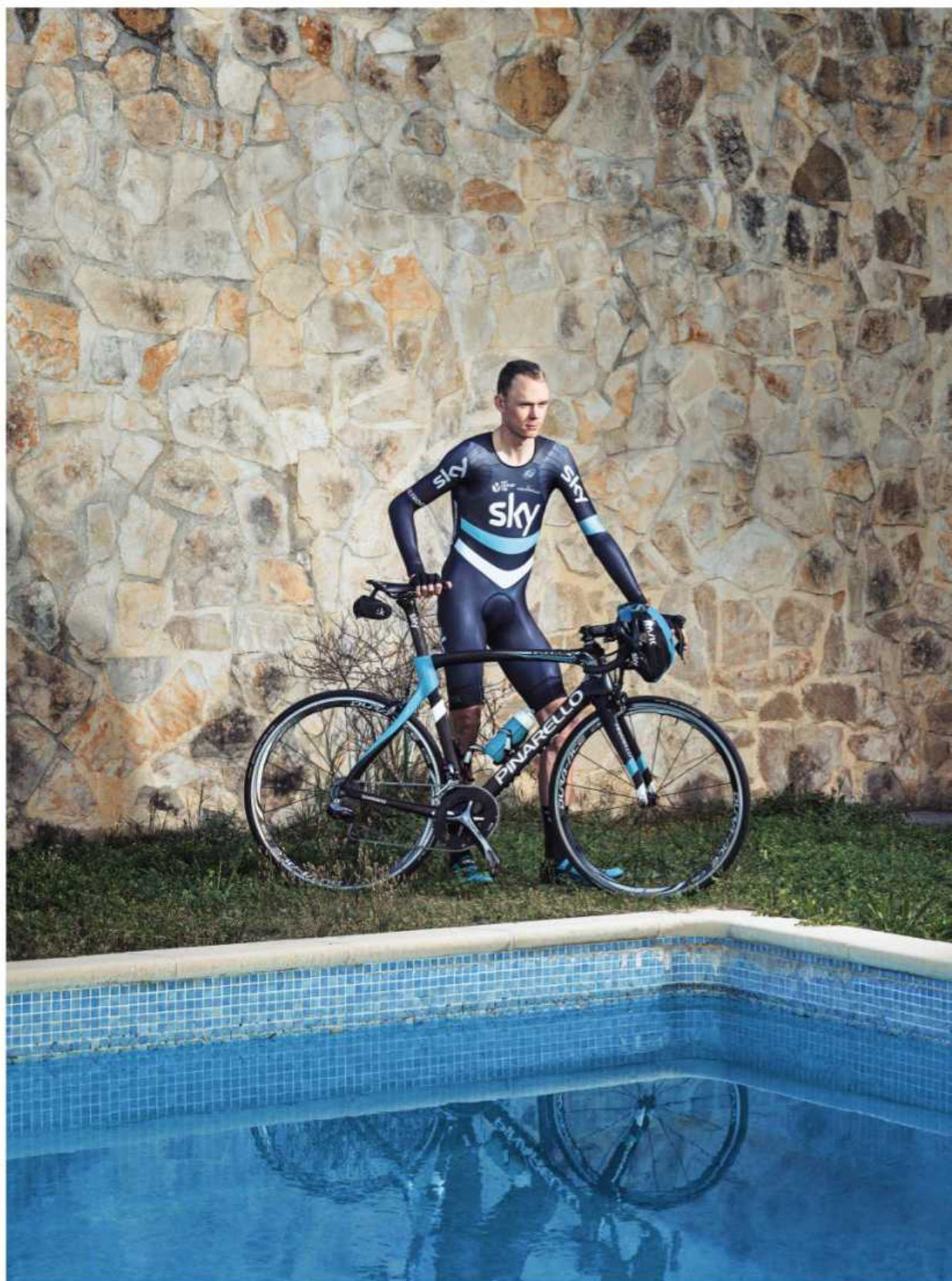
Bowers & Wilkins

124

FEATURE

What it takes to win

WIRED explores the science behind Team Sky, and their rise to the top of competitive pro cycling



PHOTOGRAPHY: [COVER AND THIS PAGE] AORTA

Two-time Tour de France winner Chris Froome takes a break from training at Team Sky's house in Nice, France




**ROYAL
ASCOT**
OFFICIAL CHAMPAGNE

CHAMPAGNE
BOLLINGER
MAISON FONDÉE EN 1829



018

START

Magic: 0. Science: 1 (sorry)

How remote sensing and mathematical modelling are revealing the secrets of bare-grass circles – no fairies required

045

IDEAS BANK

Brain food and provocations

Stop relying on computers; why good looks win elections; the refugee crisis is really an opportunity; have fun before going pro

061

EVENT REPORT

WIRED Health 2016

From AI doctors to beating bacteria and brain training – we round up everything you missed at the WIRED Health event

074

GEAR SPECIAL

Live the WIRED life

The WIRED staff's annual pick of the products we just can't live without – from Batman LEGO to personal projectors

099

PLAY

Search for inspiration

Google wants to digitise entire museum collections – including the buildings they reside in – for its Cultural Institute

117

R&D

Scientific progress

Therapeutic DNA-editing; recreating the Earth's core in a lab; how optogenetics is changing neuroscience; bug-bots

134

FEATURE

Peak output

Sport science and technology are helping athletes optimise. WIRED presents 15 innovations pushing human performance

146

FEATURE

Higher, faster, fitter, better

Whether diving the ocean or falling from space, Red Bull's High Performance Center can give competitors an edge

156

FEATURE

Remix. Rewind. Reinvent.

In an extract from his new book, Kevin Kelly explains how the era of productive remixing is enabling creative new genres

164

FEATURE

Now you see it. Now you don't

Why would China's version of Google Street View delete a factory, but leave its smoke? WIRED investigates the edits

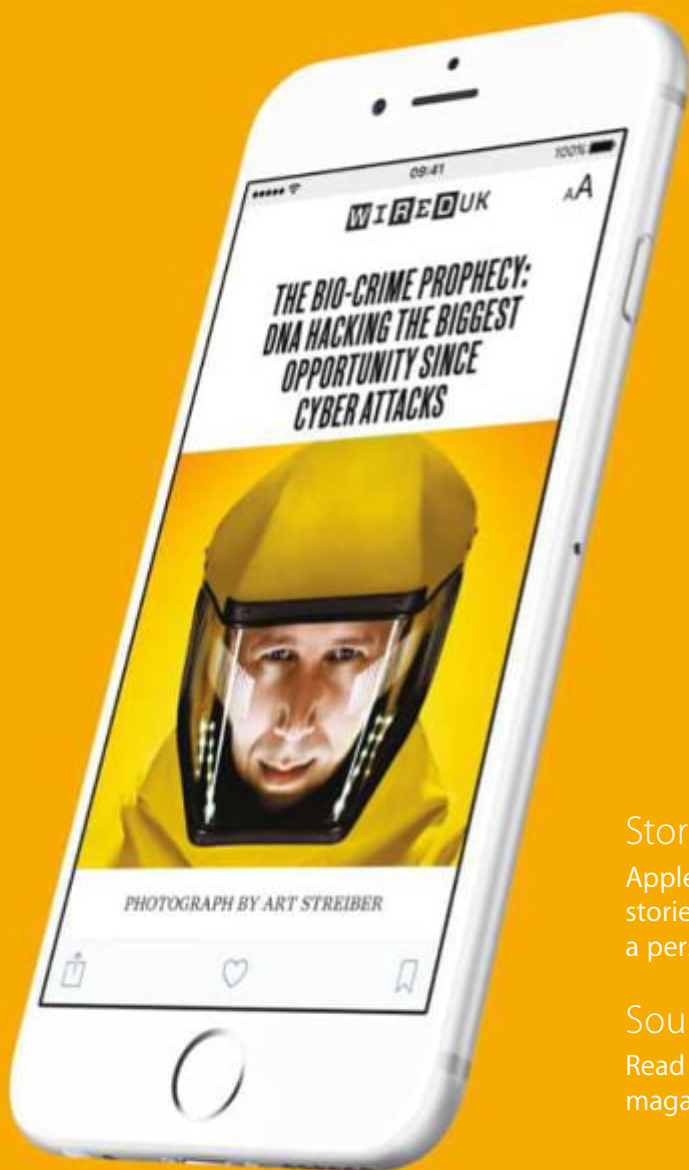


Mahiben Maruthappu, co-founder of the NHS Innovation Accelerator, who spoke at WIRED Health 2016 on how the NHS is moving into the digital age

All the bio-crime news you want.



All in one place.



Requires iOS 9. © 2016 Apple Inc. All rights reserved.

Stories you care about.

Apple News helps you discover the best stories on the topics you love in For You, a personalised news feed.

Sources you love.

Read WIRED UK and thousands of the best magazines, newspapers and blogs.



Find it on your home screen

Dynamic. Responsive. And



See more with the Audi Vision app. Download it from the App Store or Google Play, and scan this page.

Official fuel consumption figures for the all-new Audi A4 Avant range in mpg (l/100km) from: Urban 35.8 (7.9) – 60.1 (4.7), Extra purposes only. Fuel consumption and CO₂ figures are obtained under standardised EU test conditions (Directive 93/116/EEC). This in 'real world' driving conditions. Optional wheels may affect emissions and fuel consumption figures. More information is

Audi
Vorsprung durch Technik



that's just the speedometer.

In the all-new Audi A4 Avant, the Audi Virtual Cockpit* puts all the information you want right in front of you, while the standard Audi Smartphone Interface seamlessly connects to your phone.

Features that make this the perfect car for the business driver.

The all-new Audi A4. Experience progress.

Search Audi A4.



Urban 51.4 (5.5) – 78.5 (3.6) and Combined 44.1 (6.4) – 70.6 (4.0). CO₂ emissions: 147 – 104g/km. Images shown for illustration allows a direct comparison between different manufacturer models but may not represent the actual fuel consumption achieved available on the Audi website at audi.co.uk and at dft.gov.uk/vca. *Virtual Cockpit available as an option.



Editor **David Rowan**

Creative director **Andrew Diprose** Deputy editor **Greg Williams**
Managing editor **Duncan Baizley** Digital editor **Victoria Woollaston**

Science editor **João Medeiros**
Product editor **Jeremy White**
Associate editor **Rowland Manthorpe**
Assistant editor **Oliver Franklin-Wallis**
Intern **Pauline Bock**

Picture editor **Steve Peck**
Deputy picture editor **Dalia Nassimi**
Deputy creative director **Ben Fraser**
Art editor **Mary Lees**

App producer **Pip Pell**
App designer **Ciaran Christopher**

Chief sub-editor **Mike Dent**
Deputy chief sub-editor **Simon Ward**

wired.co.uk
Deputy editor **Liat Clark**
Acting deputy editor **James Temperton**
Staff writer **Matt Burgess**
Intern **Matthew Reynolds**

Contributing editors
Dan Ariely, David Baker, Rachel Botsman,
Russell M Davies, Ben Hammersley, Adam Higginbotham,
Kathryn Nave, Daniel Nye Griffiths,
Tom Vanderbilt, Ed Yong

Director of editorial administration and rights **Harriet Wilson**
Editorial business manager **Stephanie Chrisostomou**
International permissions manager **Eleanor Sharman**

Human resources director **Hazel McIntyre**
Finance director **Pam Raynor**
Financial control director **Penny Scott-Bayfield**

Deputy managing director
Albert Read

Managing director
Nicholas Coleridge

WIRED, 13 Hanover Square, London W1S 1HN

Please contact our editorial team via
the following email addresses:
Reader feedback: **rants@wired.co.uk**
General editorial enquiries and requests
for contributors' guidelines:
editorial@wired.co.uk

Press releases to this address only please:
pr@wired.co.uk
Advertising enquiries: **020 7499 9080**

Chairman and chief executive, Condé Nast International
Jonathan Newhouse

Commercial director **Nick Sargent**

Associate publisher and head of advertising **Rachel Reidy**
Senior account manager **Elaine Saunders**
Account manager **Victoria Morris**
Compiler, WIRED Insider **Cleo McGee**

Head of partnerships and events **Claire Dobson**
Partnerships director **Max Mirams**
Partnerships manager **Silvia Weindling**
Events sales executive **Nassia Matsa**

Commercial art director **Mark Bergin**
Commercial editor **Dan Smith**
Commercial project manager **Robert Hitchen**
Commercial designer **Dan Hart**

Director of WIRED Consulting and Education **Sophie Hackford**

Regional sales director **Karen Allgood**
Regional account director **Heather Mitchell**
Regional account manager **Krystina Garnett**
Head of Paris office (France) **Helena Kawalec**
Advertisement manager (France) **Florent Garlasco**
Italian/Swiss office **Angelo Careddu**
Associate publisher (US) **Shannon Tolar Tchkotoua**
Account manager (US) **Keryn Howarth**
Classified director **Shelagh Crofts**
Classified advertisement manager **Emma Roxby**
Classified senior sales executive/trainer **Chloe McDonald**

Head of digital **Wil Harris**
Digital strategy director **Dolly Jones**
Director of video content **Danielle Bennison-Brown**

Marketing director **Jean Faulkner**
Deputy marketing and research director **Gary Read**
Associate director, digital marketing **Susie Brown**
Senior data manager **Tim Westcott**
Senior research executive **Claire Devonport**
Marketing manager **Katie Bowden**
Condé Nast International director of communications **Nicky Eaton**
Group property director **Fiona Forsyth**

Circulation director **Richard Kingerlee**
Newstrade circulation manager **Elliott Spaulding**
Newstrade promotions manager **Anna Pettinger**
Deputy publicity director **Harriet Robertson**
Publicity manager **Melody Rayner**
Acting publicity manager **Richard Pickard**
Subscriptions director **Patrick Foilleret**
Subscriptions marketing and promotions manager **Claudia Long**
Marketing and promotions manager **Michelle Velan**
Creative design manager **Anthea Denning**
Senior marketing designer **Gareth Ashfield**

Production director **Sarah Jensen**
Commercial production manager **Xenia Dilnot**
Production controller **Alicia Shepherd**
Production and tablet co-ordinator **Skye Meelboom**
Commercial senior production controller **Louise Lawson**
Commercial and paper production controller **Martin MacMillan**
Commercial production co-ordinator **Jessica Beeby**
Tablet production controller **Lucy Zini**

Directors **Jonathan Newhouse** (chairman and chief executive), **Nicholas Coleridge** (managing director), **Stephen Quinn,**
Annie Holcroft, Pam Raynor, Jamie Bill, Jean Faulkner, Shelagh Crofts, Albert Read, Patricia Stevenson

**CLINIQUE
FOR MEN**

Power tools
for men's skin.



NEW Clinique For Men Sonic System Deep Cleansing Brush and Charcoal Face Wash

With charcoal grey bristles and more than 9000 sonic vibrations per minute, our men's Sonic Brush cleans more effectively than hand washing alone. Preps for a smooth shave, too. Team with Charcoal Face Wash for a detoxifying, deep-pore clean.

Available in selected stores and on clinique.co.uk only.

The perfect Father's Day Gift. Free.*

Receive your free 6 piece gift when you purchase any two Clinique For Men products. Available from 2 – 18 June 2016 at Clinique counters and on clinique.co.uk.

*Free with the purchase of any two or more Clinique For Men products.
Alternatively, with the purchase of a single Clinique For Men Sonic System Cleansing Brush, from Thursday 2 until Saturday 18 June 2016.
One gift per Client, while stocks last. Gift contains promotional size items.



MAKING WIRED



LOOKING FOR A SIGN

Photographer Michael Sugrue set out for what may be one of the most dangerous places in the US – the very active tectonic plates of the San Andreas Fault – to shoot Andres Meira, inventor of the Grillo earthquake sensor: “The brief was to find a ‘San Andreas Fault’ sign that also had the sweeping Californian wilderness behind it, to give a sense of scale. That’s actually a lot harder than it sounds. We had a reference image from WIRED’s picture editor, and it took a bit of internet sleuthing to find out where it was. We found the Google Maps co-ordinates and arranged to meet Meira there. Except when we arrived, there was no sign. We had to drive up and down the road until we found the right place – there’s no mobile coverage in the desert...”



DECISIONS, DECISIONS...

Making it into WIRED’s Gear section is a tough call – but when we’re running our annual round-up of things we love, we get extra picky. Here, product editor Jeremy White, deputy creative director Ben Fraser and deputy picture editor Dalia Nassimi are being ruthless. “It can’t just be hipster bookshelf porn – though looking good is important,” says Fraser (centre). “It’s got to improve your life, too.”

CONTRIBUTORS

JOÃO MEDEIROS



WIRED’s science editor gets the inside track on how Team Sky came to dominate pro cycling. “Science is at the core of what they do, along with a sophisticated understanding of psychology,” he says. “Their riders, such as Chris Froome, thrive on defeating pain.”

PAULINE BOCK



Bock is our editorial intern – you’ll have seen her name throughout the last several issues. “I look for the anecdote behind the innovation,” she says. “And I learn something every time I write for WIRED.” Fancy interning? Email interns@wired.co.uk for an application pack.

PETER DIAMANDIS



The co-founder of Singularity University and the XPRIZE Foundation writes about a new approach to the refugee crisis – seeing it as an opportunity: “Refugees bring skills and assets which can benefit the communities where they are living,” he says.

ANGELA DUCKWORTH



The author of *Grit* shares her findings on the nature of hard work and success in Ideas Bank. “Grit and grind are different,” she says. “If you work like a dog but find zero joy or meaning in your toil, you’re not gritty. Exalting only long hours isn’t the right message.”

JEREMY WHITE



WIRED’s product editor turns his attention to all things horological this month, with our annual TIME supplement. “It’s a chance to celebrate the new technology of timekeeping,” he says, “from oil-suspended mechanisms to watches that are near bulletproof.”

PRADA

LUNA ROSSA SPORT



SPORT

EAU SPORT



EVENT

COCKTAILS IN TEL AVIV

WIRED recently gathered 80 of Tel Aviv's top founders and investors for cocktails in the city's Norman Hotel, sponsored by Pictet. We wanted to find out how such a tiny country is producing so many tech successes. Our conclusion: it's not the falafel, it's because they aim for a global market from the start.



SUPPLEMENT

TIME: THE DIRECTOR'S CUT

We hope you're enjoying the free *Time* supplement with this issue. You may have noticed that some of the pages have a Digital Extra! badge on them (there's one on the bottom-right corner above). They're there to let you know that if you want to explore these tantalising timepieces in more detail, you can download the supplement – it's also free digitally – for your iPad or iPhone. You'll find it in your device's library alongside the regular issues. The time is now...

WIRED AWAKE

DAILY BRIEFING

Sent to your inbox by 8am every weekday, it's an essential catch-up of what's going on in the WIRED world. **Subscribe at wired.co.uk/wired-awake**



WIRED PODCAST

THE WEEKLY VIEW FROM WIRED

Haven't listened to Episode 267 of the WIRED podcast yet? Then you won't know which London Underground line had a proposed name of the Viking Line, or how many different wolf dialects there are, or how long Mike the chicken survived for after his head was chopped off. For all the answers and more, **listen at wired.co.uk/podcast, or search WIRED UK on iTunes. Plus, don't forget our monthly WIRED Stories feature-length podcast**

THE WIRED UNIVERSE

WIRED.CO.UK

EVE OF THE SUPERFAN

This month, wired.co.uk explores the people and politics of *EVE*, one of the longest-running and most popular massively multiplayer online games. The recent *EVE* Fanfest convention in Reykjavik, hometown of the game's developer CCP, even included a speech from Icelandic president Ólafur Ragnar Grímsson. Could be the start of a trend – we can picture Mr Cameron at the next EGX fan-fest. **Read more at wired.co.uk**



24-HOUR WIRED

WANT MORE?
TRY THESE

- Facebook [wireduk](https://www.facebook.com/wireduk)
- Twitter [@WiredUK](https://twitter.com/WiredUK)
- Google+ [+wireduk](https://plus.google.com/+wireduk)
- Instagram [@wireduk](https://www.instagram.com/wireduk)
- Tumblr [wireduk](http://wireduk.tumblr.com)
- wired.co.uk/podcast

APPLE NEWS

THE WIRED
NEWS FEED

Five of the best WIRED stories, drip-fed into your smartphone's *Apple News* feed every 24 hours. **Select *WiredUK* in *Apple News*.**



VALENTINO

VALENTINO
UOMO
THE MASCULINE FRAGRANCE



Panasonic

MASTERING THE MAGIC OF LIGHT
TRUE TO THE DIRECTOR'S VISION

VANJA ČERNJUL, ASC
DIRECTS 'CONVERGING BEAMS'

THE AWARD-WINNING, ULTRA HD PREMIUM™ DX902 SERIES

Introducing our new DX902 televisions, available in 65" and 58". Thanks to High Dynamic Range (HDR), every picture is faithfully reproduced as the filmmaker intended, with stunning clarity and incredible detail even in high-contrast conditions. Tuned by Hollywood professionals to achieve industry-benchmark Ultra HD Premium™ and THX® 4K certification, the power of pure cinema is now showing in your home.

See Vanja's short film in-store to truly appreciate the 4K HDR difference, or see his take on HDR at panasonic.co.uk/4KPro



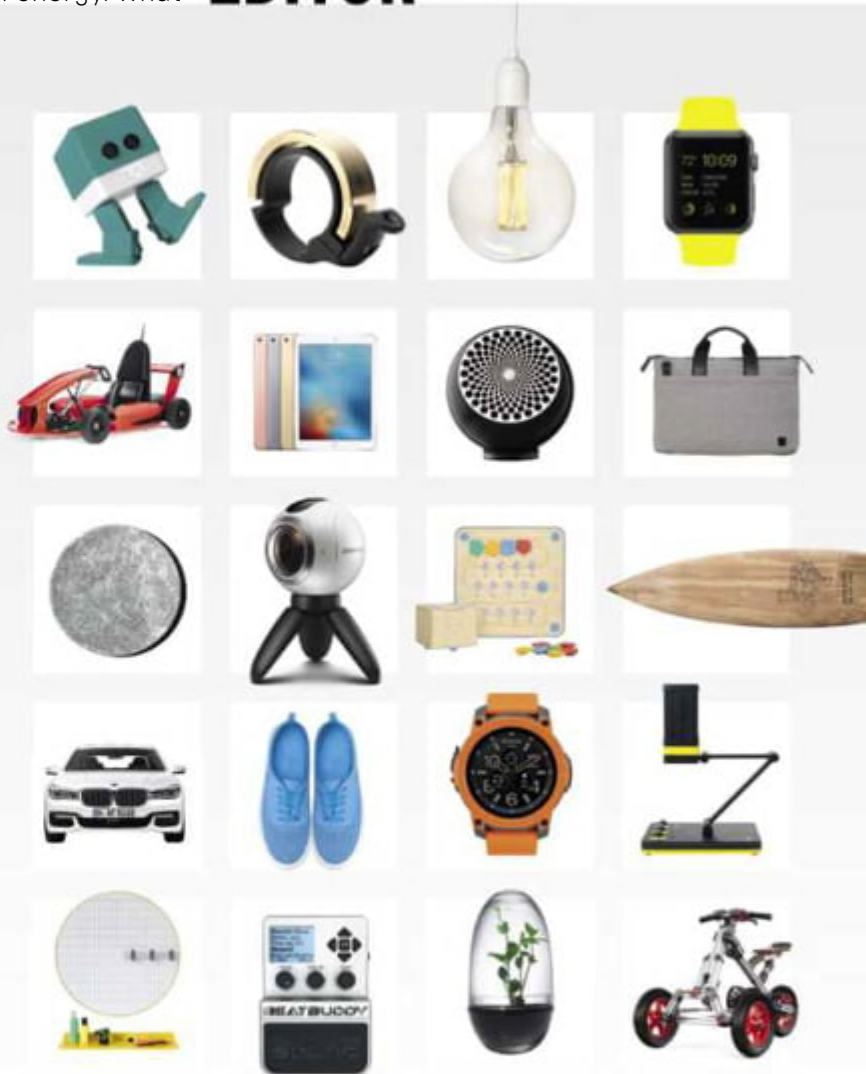
This is not WIRED's sports issue. Let's get that clear from the start. Yes, we go deep inside Team Sky's bike-training squad, hold our breath alongside the most ambitious Red Bull athletes and deconstruct Lewis Hamilton's Formula 1 steering wheel. But that's because we wanted to understand how to optimise performance – from the psychology that enables winning to the science of boosting personal energy. What could WIRED readers – whatever their individual levels of fitness – learn from the world's best-prepared, most data-enabled sports teams that they could then apply to their personal and professional lives? How could we all embrace the lessons learned daily by sport's ultimate winners?

That's why it's our science editor, not a sports specialist, who's written both our cover story on Chris Froome's training regime and also our investigation of Red Bull's extraordinary high-performance unit. João Medeiros, who by day edits WIRED's R&D and Ideas Bank sections, wanted to know how today's peer-reviewed science can be applied in ways that give competitive sports stars an edge – while offering lessons to the rest of us. So this issue you'll meet Andy Walshe, a PhD in human movement studies, whose philosophy of "celebrate failure" helped reinforce the learning processes that led Felix Baumgartner's record-breaking 39km Red Bull-sponsored space jump, and Tim Kerrison, who combines physiology, nutrition, performance analysis and energy optimisation when training cyclists such as Froome. And you'll discover the psychological "programming" that may help smash the two-hour marathon record. Just as in a fast-growth business, it takes a multidisciplinary set of expertise – from design to data analytics – to prepare for winning. Because if you can't measure, you can't improve.

For years our editorial team has been longing to celebrate the UK innovators who most excite us. I'm delighted that, thanks to Audi's generous support, this month we finally get to launch what I hope will be an annual high-profile awards programme. The WIRED/Audi Innovation Awards are built around seven categories, ranging from AI to product design, and we've persuaded some amazingly accomplished people to lend their expertise in an intense judging process. Look out for our coverage in the months up to the inaugural ceremony this November.

Meanwhile, enjoy this extended issue of WIRED.

FROM THE EDITOR



Above: turn to p74 to start compiling your summer gear shopping list

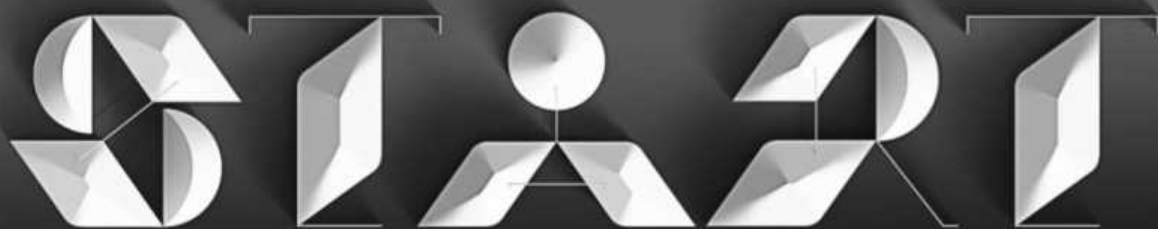
PHOTOGRAPHY: ROGER STILLMAN



David Rowan

David Rowan

DMA MAGAZINE OF THE YEAR 2015 • DMA COVER OF THE YEAR 2015 • DMA TECHNOLOGY MAGAZINE OF THE YEAR 2015 • DMA MAGAZINE OF THE YEAR 2014 • BSME ART DIRECTOR OF THE YEAR, CONSUMER 2013 • PPA MEDIA BRAND OF THE YEAR, CONSUMER 2013 • DMA TECHNOLOGY MAGAZINE OF THE YEAR 2012 • DMA EDITOR OF THE YEAR 2012 • BSME EDITOR OF THE YEAR, SPECIAL INTEREST 2012 • D&AD AWARD: COVERS 2012 • DMA EDITOR OF THE YEAR 2011 • DMA MAGAZINE OF THE YEAR 2011 • DMA TECHNOLOGY MAGAZINE OF THE YEAR 2011 • BSME ART DIRECTOR OF THE YEAR, CONSUMER 2011 • D&AD AWARD: ENTIRE MAGAZINE 2011 • D&AD AWARD: COVERS 2010 • MAGGIES TECHNOLOGY COVER 2010 • PPA DESIGNER OF THE YEAR, CONSUMER 2010 • BSME LAUNCH OF THE YEAR 2009





MAGIC: 0 SCIENCE: 1 (SORRY)

The San people of Namibia believed these rings were bubbles blown by a dragon under the Earth. For years, scientists struggled to identify the cause of phenomenon, with theories ranging from poisonous bushes, carbon dioxide leakage and ant or termite activity. But, sadly, such fanciful origins have now been ruled out. The circles, ranging from two to 15 metres in diameter – shown here in the Namib-Naukluft National Park in Namibia – emerge from the behaviour of grasses in very dry regions. “It’s a self-organising mechanism,” says Stephan Getzin from the Helmholtz Centre for Environmental Research in Germany, who has co-authored a “fairy circles” study.

Grasses suck up water and nutrients, killing vegetation to leave spots with a hard crust. “When it rains, the circles are a source of water,” says Getzin. “After rainfall, the circles disappear.”

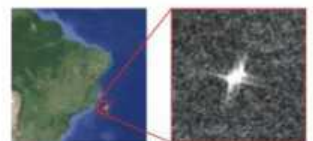
Getzin and his researchers used fieldwork, remote sensing, spatial-pattern analysis and mathematical modelling to map the grass patterns in Namibia and the western Australian outback, where a 20km² area of fairy circles was recently observed. “From two different ecosystems, the same instability creates a similar pattern,” explains Ehud Meron, from Ben-Gurion University of the Negev, Israel, who did the modelling. But the fairy circles still hold some secrets – for now. “We plan to use drone imagery to understand how the plants arrange themselves,” says Getzin. **Pauline Bock** in.bgu.ac.il/en



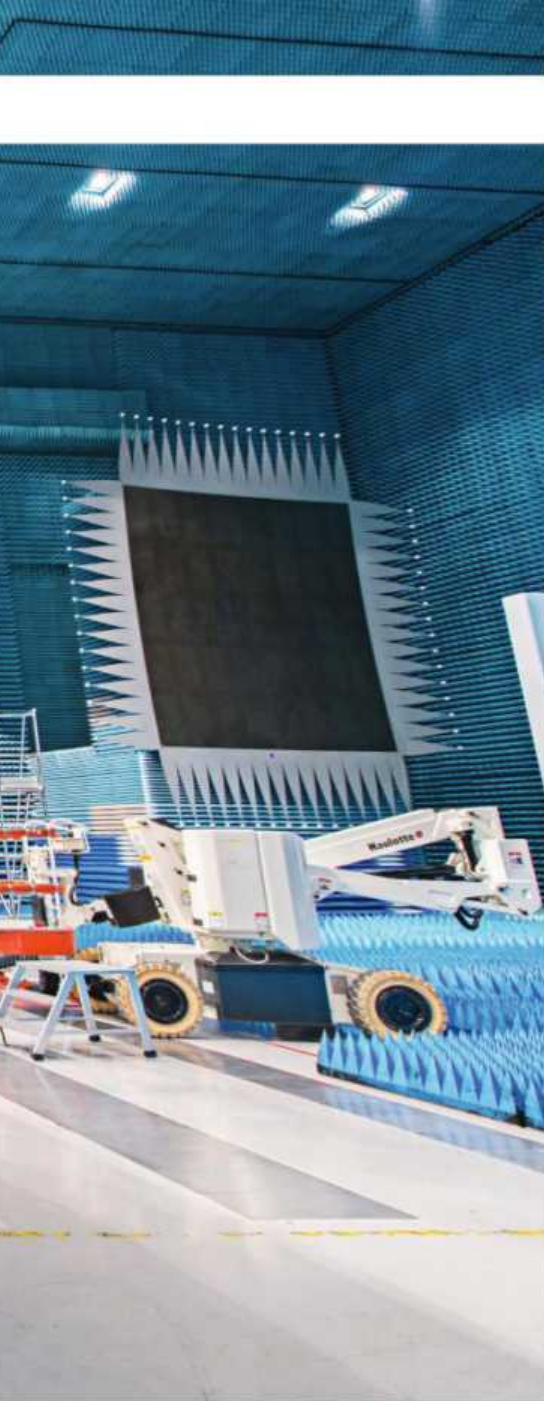
T

THIRTEEN MINUTES. THAT'S HOW LONG IT TOOK aerospace engineers waiting in Germany to see an image of a group of ships near the Brazilian coast (*inset, right*). For the European Space Agency (ESA), it's a record. "The typical duration to get the image to an end user in Europe is in the range of hours," says Michael Witting, ESA's European Space Data Relay (EDRS) project manager.

The image was the first proof-of-concept of Europe's forthcoming SpaceDataHighway, a high-speed satellite-to-Earth data connection developed by the ESA and Airbus Defence and Space, made possible by satellites such as the EDRS-A (*above*) being prepared for its launch on January 29. It sends information to Earth at 1.8 gigabits per second, more than 90 times the amount of data that an average internet connection can send in the same time. To create the image, an ESA satellite acquired radar data of the area while circling in low Earth orbit. Further out, at 36,000 kilometres above sea level, a data relay device picked up the satellite data over a laser transmission link and beamed it back down to a ground station in Germany. There, engineers processed the picture within five minutes. Satellites typically send image data to ground stations near the North and South Poles, which they fly over every 100 minutes. But because the EDRS is always in view of Europe, it can send satellite data directly to ground stations in Germany, Belgium and the UK. "It's like a TV broadcasting satellite," says Witting. "They're always overhead and sort of rotate around with you." **Tina Amirtha** edrs-spacedatahighway.com



This grainy picture may not look like much, but for, say, first responders to major disasters, even hour-old imagery can be useless. EDRS can send images of large areas of Earth and ocean every few minutes



SUPER DUPER DATA ROUTER

The ESA's latest satellites can outpace Earth-bound broadband speeds for near-real-time images

APPS OF THE MONTH



WIRED

ROLO

This calendar app uses animations and a circular design to let you see your day, week and year in a single swipe. It's probably easier to set a date using your normal calendar, but *Rolo* is still a worthwhile accessory, especially if you're interested in seeing how life divides into work and play. *iOS, free rolotime.com*



EQUITABLE

EquiTable bridges the wage gap by splitting restaurant bills based on each person's race and gender. The app uses labour statistics to adjust for income inequality, calculating how much each person should contribute. Feel unfairly burdened? Never fear, the app has a "protest" button. *iOS, free equitableapp.com*



UNLOCKD

As advertisers scramble for an answer to ad-blockers, *Unlockd* may have a neat solution. It offers to give you a discount on your monthly phone bill in exchange for showing you an advert every third time you unlock your smartphone. The scheme is backed by Yahoo!, Lyft and Starbucks. *Android, free unlockd.com*



ZCAST

Amateur podcasters rejoice: *ZCast* makes it possible to broadcast straight from your smartphone. The app harnesses existing messaging software at parent company Zula and links to Twitter to help would-be Sarah Koenigs reach new audiences. Handily, co-hosts can join the show live while on location. *iOS, free about.zcast.co*



THE WESTPORT INDEPENDENT

Worried about the decline of print media? Try taking control of your own newspaper. As well as managing marketing budgets and deciding the headline, this game examines your ability to fight for a free press under pressure from a propaganda-pushing government. *iOS, Android, £3.99 doublezeroonezero.com*



WEIRD

PILLOW

This not-creepy sex app encourages physical and emotional intimacy with ten listen-and-follow audio guides. The experiences, known as "episodes", last five to 25 minutes. Pick narration by a British female or an American male, then set your phone to "do not disturb". *iOS, free [IAP £7.99, £39.99] pillow.io Alex Jordan*



NINETY SECONDS TO DUCK AND COVER

**Andres Meira is building
a cheap sensor network to
warn of earthquakes**

E

ARTHQUAKES CAN STRIKE QUICKLY, SO JUST A

few seconds' warning makes a difference. Andres Meira's mission is to save lives in Mexico – one of the most seismically active countries in the world – by using low-cost sensors to send tremor updates via an app. "You measure the movement of the ground where the earthquake is occurring and transmit an alert to vulnerable cities," says UK-born Meira, 39 (*above*).

Earthquakes travel at 4kps, whereas internet latency in Mexico is less than half a second, so cities further away from the Pacific fault line can

receive warnings of up to 90 seconds. In 2014, Meira created Grillo, a receiver to give Mexicans access to the government's early-warning signal – only to find it limited and unwieldy. "We changed course and created our own infrastructure which would be more reliable and scalable," he says. The updated Grillo uses an accelerometer connected to a microcontroller chip, which sends the movement data to a local router. "What we're doing is applying algorithms – so it's saying, it's not a truck, it's an earthquake," says Meira. Each device costs \$50 (£35), a fraction of the \$20,000 traditionally spent on more conventional sensors, and incorporates a loudspeaker so it can act as an alarm.

Meira is installing the 10cm x 10cm sensors in schools, hospitals and hotels, and at press time was negotiating a contract with the government "so we can use government buildings – that is, places with reliable internet". The *Grillo* app is free; in the long term, the company intends to make money by selling an enhanced version of the system to businesses which will give them the option to shut down elevators, gas pipes and generators. For Meira, though, the real aim is to bring a small measure of control to people living in seismic zones across the world. "There's a primal fear that overtakes you," he says. "Having 90 seconds allows you do something about it." **RM** grillo.io



Google gave Grillo a year's free hosting, so Grillo's sensors can send a stream of ground acceleration data to the cloud



dial

**Over 20 million tracks
at no extra cost.
Exclusively on Three.**



Three.co.uk

Music service provided by i.am+



PLANTS VS POLLUTION

Meet tree 2.0 – a space-saving, particulate-eating perennial

This four-metre-high vertical garden in Oslo inhales pollution and exhales fresh air – doing, its creator claims, the work of 275 trees in one per cent of the space. Dresden-based Green City Solutions' CityTrees have been installed in four cities across Germany and Norway, and will soon arrive in Hong Kong. Each holds 1,682 pots of moss which extract particulate matter (PM) – soot, dirt and other pollutants – from the air. Bacteria living on the moss digest PM, and the moss digests the bacteria.

Absorbed PM ranges from 0.1 microns wide to ten microns – the smaller particles being the most dangerous, as they can get deep into human lungs and from there enter the bloodstream. "Polluted air is

the cause of one in seven deaths worldwide," says Green City Solutions CEO Dénes Honus. "Just 10µg of pollutants per m³ of air will shorten a life span by half a year."

Built into the unit is a Wi-Fi beacon and a rainwater-collection unit, as well as a nutrient tank and sensors that gather data from the CityTree and its surroundings.

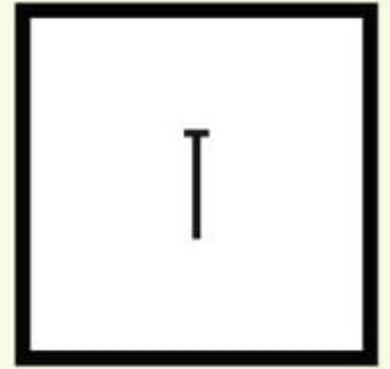
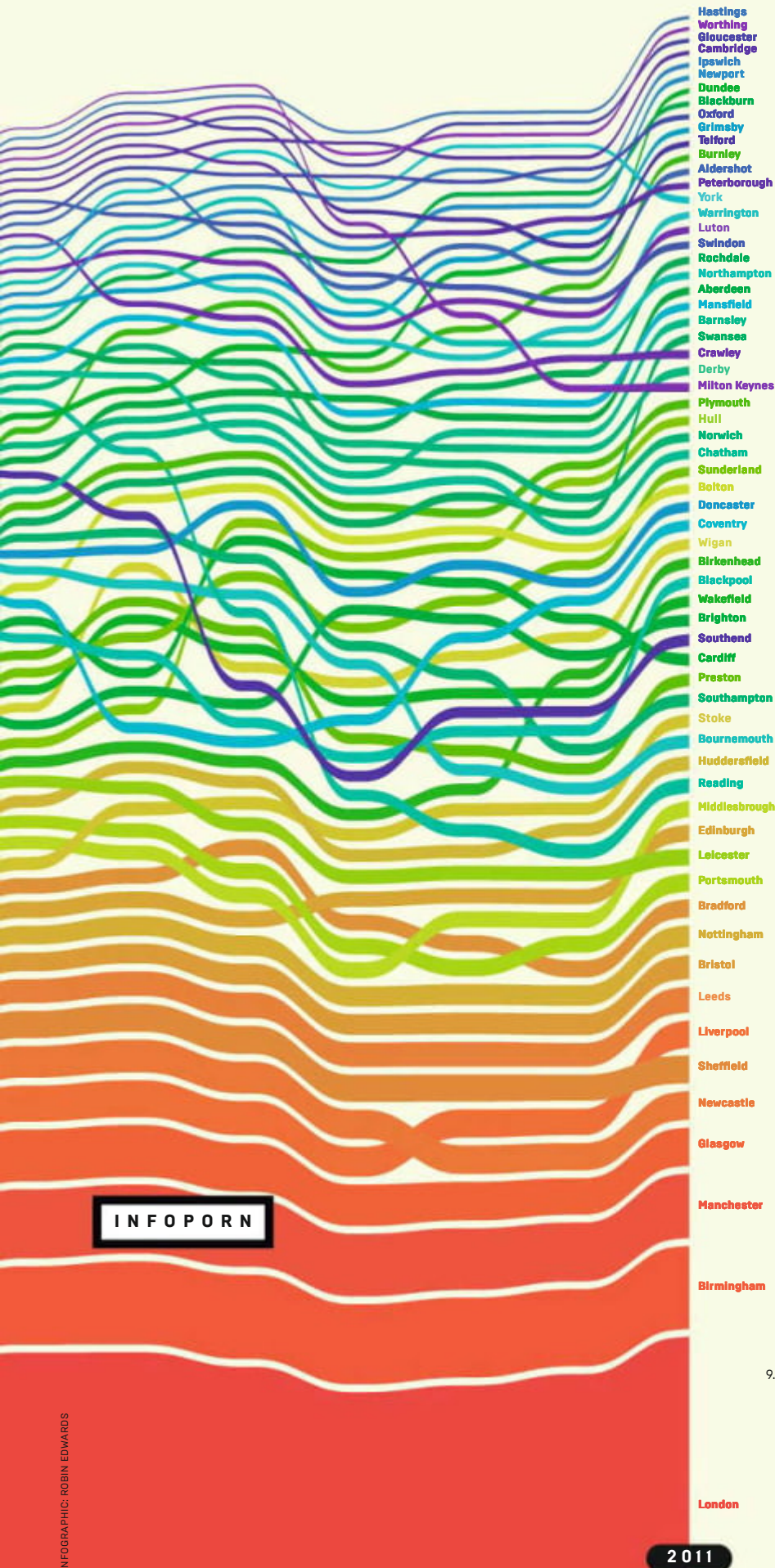
Each CityTree costs €22,000 (£17,600), but buyers may be able to recoup this through advertising, as the units include NFC and iBeacon technology. The vertical beds can be planted to display anything from logos to QR codes. How very digitalis.

Katie Scott *green*
citysolutions.de

CITY MAPPER

London is always expanding –
but it makes other cities grow, too

Worthing
Milton Keynes
Luton
Crawley
Peterborough
Cambridge
Southend
Telford
Gloucester
Oxford
Swindon
Aldershot
Hastings
Ipswich
Newport
Doncaster
Grimsby
Mansfield
Coventry
York
Warrington
Bournemouth
Northampton
Blackpool
Reading
Chatham
Barnsley
Derby
Norwich
Southampton
Swansea
Rochdale
Blackburn
Aberdeen
Brighton
Cardiff
Dundee
Wakefield
Birkenhead
Burnley
Plymouth
Preston
Sunderland
Hull
Leicester
Portsmouth
Middlesbrough
Bolton
Wigan
Stoke
Huddersfield
Nottingham
Edinburgh
Bristol
Bradford
Sheffield
Leeds
Newcastle
Liverpool
Glasgow
Birmingham
Manchester
London



RACK THE GROWTH OF THE UK'S cities over the last 100 years and a familiar pattern emerges: northern and coastal decline, and the growth of London. But the devil is in the detail.

"London doesn't function in isolation, it's part of a network of cities," says Robin Edwards, a research assistant at University College London's Centre for Advanced Spatial Analysis. "Population centres are feeding on London – those that provide critical geostructural roles are the ones that have grown the most."

By combining census data from 1901 to 2011 with official assessments of urban boundaries, Edwards was able to track the rise and fall of cities by using a mapping technique called rank-size plots. The result (*left*) reveals that cities close to London – the likes of Reading, Crawley and Southend – experienced the most rapid growth. The planned town of Milton Keynes (80km from London) grew from a population of zero in 1967 to more than 229,000 in 2011. In contrast, in the industrial north Blackburn, Burnley and Wigan suffered heavy declines. But the dataset struggles to tell the most significant story of urban population change: commuters.

"You can't consider London by itself," says Edwards. "You have to look at least to the commuter catchment area." That covers the "cluster" of Cambridge to Brighton and Bristol. Edwards argues that improved transport links will make these clusters bigger. The fate of cities does not exist in isolation. **James Temperton** bartlett.ucl.ac.uk/casa

The data indicates that London's population reached 9.48 million by 2011



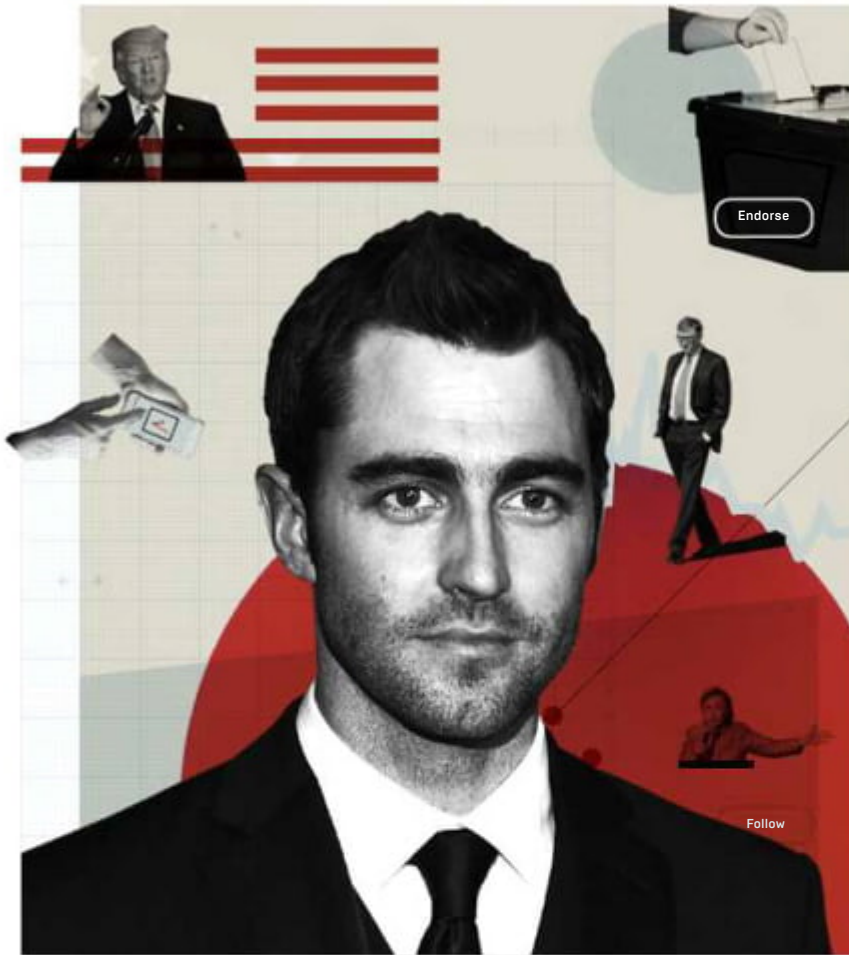
Clean your way to white with Philips Sonicare.

With 62,000 powerful movements per minute, Philips Sonicare DiamondClean is clinically proven to gently lift away stains like coffee, red wine or tea, for a natural white smile in just one week.

innovation  you

Available at
amazon

PHILIPS
sonicare



TRUST ME, I'M NOT A POLITICIAN

Ben Rattray of Change.org wants to harness the power of the network to reform the way we elect our leaders

BEN RATTRAY WANTED TO HELP people influence politicians, so in 2007 he set up Change.org, a website where anyone could start their own petition. The project grew slowly at first, taking four years to reach a million subscribers. Then one case – a call to end “corrective rape” of lesbians in South Africa – gave it the push it needed. Today, Change.org has 145 million subscribers, including 35 million in the US, and claims to be expanding at the rate of a million a week. “People are winning all the time, in fact almost once an hour around the world on the site,” says Rattray.

Yet success only shows how much more there is to do. Even though each victorious petition changes a politicians’ mind, its impact is isolated, piecemeal, because the system remains the same. So San Francisco-based

Rattray, 35, is embarking on a new mission: to change politics itself – and the US presidential election on November 8, 2016, is as good a place to start as any.

Rattray’s tool is a mobile web app called, simply, *Change Politics*. Launched for the US election, *Change Politics* is a publishing platform for endorsements – or, more simply, a social network for advice on how to vote. “You follow the people and the organisations that you trust the most, like you follow people on Twitter,” explains Rattray. In return, *Change Politics* takes the endorsements of your connections, as well the reasons they give for supporting candidates, and uses them to create what Rattray calls a “personalised ballot”, which users can access as they go into the polling station. “You open your phone,” he says, “and it has an additional ballot that looks exactly like your physical ballot, with all the recommendations overlaid on it.” The isolation of the voting booth is no more – if you have a phone, you’ll have access to advice.

Newcomers to *Change Politics*, which was trialed at the Iowa and New Hampshire presidential primaries before being given its first full test at the California primary on June 7, will be greeted with recommendations of endorsers to follow and quizzes to work out who they should connect with. ➤

To make sure that influencers get involved, Rattray is gathering a group of “verified endorsers”: prominent figures, and not just from politics. So who’ll be on the list? “Bill’s an investor of ours, I’ll think he’ll want to be an endorser.” That’s Bill as in Bill Gates. Alicia Keys, who has started petitions on Change.org, is also mentioned, as is Obama advisor David Plouffe. “It’s those people we’re excited about getting involved,” Rattray says. “They have this currency of trust but they haven’t transformed it into a currency of political influence.”

The same goes for anyone with social clout. Unlike most voting apps, *Change Politics* will ask for endorsements even in the most minor local races, where little-known individuals fight it out for everything from city council to county supervisor. For voters, it’s a quick way to check who’s who, or at least who’s popular. (Most US states allow the use of smartphones in polling booths, as does the UK, although it’s not always legal to take photographs.) For people or organisations with influence, it’s a chance to sway a contest. “We talk about being easy to access, trusted and viral,” says Rattray. “Viral as in you will end up having people with substantial influence, who want to push their endorsements and collect followers.”

Voter apps are hardly in short supply, and each presidential election brings a fresh infusion. (Releases for 2016 include information apps *Pollenize* and *PolitiFact*, and *Voter*, an app that uses *Tinder*-style swiping to pair voters and candidates.) Rattray says that the social network aspect of *Change Politics* makes it far more powerful than previous initiatives. “It changes the incentives of elected officials. If you have the choice between raising \$25,000, or convincing someone who has 25,000 followers on *Change Politics* – meaning that person’s endorsement appears on the mobile phone of 25,000 people that trust them just before they vote – it’s worth way more than \$25,000.” His ambition stretches far beyond providing voters with information: he wants to change the way politicians reach and build support. He leans forward, clearly animated. “We want to build a new influence graph for politics, where the most trusted people are the most influential.”

Rattray meets WIRED at Change.org’s new London HQ – with 11 million

subscribers, the UK is Change.org’s second largest territory. The HQ is located on the first floor of a smart black building close to Liverpool Street. Inside, in gleaming, light-filled rooms, young activists work at standing desks, picking occasionally at bunches of Deliveroo-ed grapes. “They’re probably the main powerhouse of digital politics,” says Carl Miller, research director of the Centre for the Analysis of Social Media at the think tank Demos.

Whether a personality-led approach is the best way to choose candidates is another question. “Networks such as Twitter are so based on personality, I worry that policy gets eclipsed,” says Miller. “This initiative seems to be going down that path as well.” Demos research during the 2015 UK general election showed that voters used social media extensively during election campaigns – but to comment on personality rather than policy. He sees the same thing happening in the US. “You might say Donald Trump’s surge is based on that distinction. In focusing on Trump the man, people aren’t examining the things he stands for.”

Rattray says the app, which will be advert-free (unlike Change.org, which charges companies to promote petitions on the site), has mechanisms designed to promote informed decision-making: people will be able to endorse endorsers, and a “Google Page Rank of trust” will algorithmically favour the most reliable and independent. But as it will also pull in Facebook and Twitter followers, *Change Politics* could simply reinforce the dynamics of social media. Will it be another platform for celebrities and self-promoters? More pressing: could it – should it – have stopped Donald Trump? “Our goal isn’t to stop anybody,” says Rattray. All the same, his intentions are clear. “If you have a world where people are using the recommendations of the people they trust, not just name recognition, to drive their voting behaviour, then it may change who they vote for.”

Rattray has plans for global expansion, including bringing the app to the UK. First, though, there is the small matter of the US presidency. “We think we will have several million users that will use this the first iteration in 2016,” he says. “A substantial number of races get swayed by one or two per cent. So even if you would have a few per cent of the population that are using the platform, we think we can sway it.” Ultimately, he now believes, the only way to change politics is to change politicians’ incentives. “It’s all about votes. If you can deliver votes, you can change behaviour.” [RM changepolitics.org](http://RM.changepolitics.org)

‘WE WANT TO BUILD A NEW INFLUENCE GRAPH FOR POLITICS’



Perception of trustworthiness is a huge problem for politicians – US public trust in its leaders has tumbled since the days of Lyndon B. Johnson in the late 60s

INFOGRAPHIC DATA: PEW RESEARCH CENTER, FROM A SAMPLE OF 6,000 AMERICANS

Accelerating insights



7 of the 10 World's Most Admired Companies
drive business decisions using
Data Analytics from Hewlett Packard Enterprise.



SORRY, STITCHES— YOUR TIME MAY BE UP

Maria Pereira can mend a broken heart. Her secret: light-activated glue that can set anywhere

030 / START / SEAMLESS SURGERY / WTE



Maria Pereira, head of research at Gecko Biomedical, with a sample of her GB02 adhesive

S

URGERY HAS

been suture-based for centuries, and although it has advanced beyond bone needles and silk thread, the process still harms the human body. "Sutures are time-consuming, damage tissue and are technically challenging," says Maria Pereira, head of research at Paris-based Gecko Biomedical, whose bio-inspired alternative it says can replace stitches. Its adhesive is viscous, hydrophobic, biodegradable and cured by LED light. Unlike other glues, which can be washed away by water, it can be placed in wet environments such as the heart, where it works as both a sealant and a scaffold for tissue to grow over.

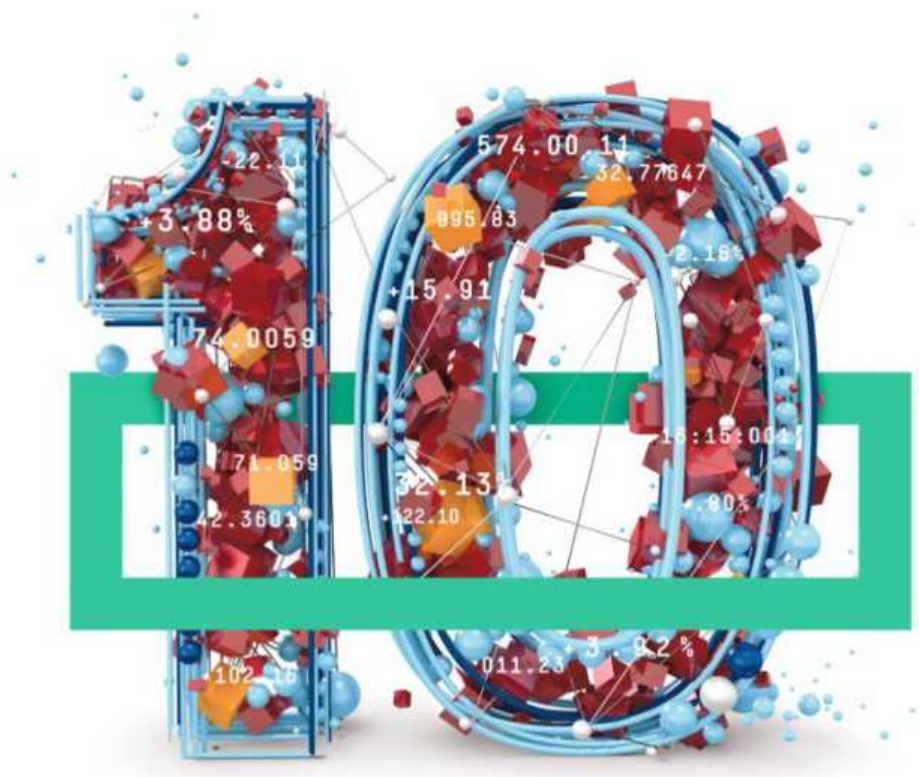
Pereira, 30, invented the glue in 2010 while a bioengineering PhD student in the MIT Portugal Program. Doctors at Boston Children's Hospital had approached her supervisor, Jeff Karp of the Harvard-MIT Division of Health Sciences and Technology, with a problem: how to close defects in a newborn baby's heart without sutures. A newborn's heart is as large as its

fist, so operations are extremely delicate. Pereira looked to nature for inspiration. "Understanding the basic principles of how things work is very important in developing new technologies," she says. Her sealant can stay sticky inside a beating pig's heart by mimicking the viscous, hydrophobic secretions of snails and sandcastle worms.

Karp and a group of prominent scientists and entrepreneurs founded Gecko Biomedical in 2012, hiring Pereira as head of research. Its first product made from the adhesive, GB02, acts as an adjunct to sutures in vascular reconstruction surgery and will go into clinical trials this spring, with the aim of securing regulatory approval in the first half of 2017. The company, which has received more than €9 million (£7m) in funding, is also working on GB04, which could end the need for sutures altogether. "The goal is to make surgery simpler and to change how it is done." **Daniela Walker** geckbiomedical.com

WIRED	TIRED	EXPIRED
Breakthrough Starshot	CisLunar1000	Virgin Galactic
Schaft	Cyberdyne	Omni Consumer Products
Bot impersonator	Bot curator	Bot trainer
Doctor Strange	Doctor Evil	Junior doctors
Markov-chain novelists	AI copywriters	AI sportswriters

Accelerating analysis



10 of the Forbes 10 World's Most Valuable Brands
gain insights and create value with
Hewlett Packard Enterprise big data solutions.

hpe.com/analysis

© 2016 HPED LP. Source: Forbes Most Valuable Brands 2015; HPE Customers 2013 Q3 - 2015 Q2.

Accelerating next



**Hewlett Packard
Enterprise**



F

FORGET SCOURING THE SEA FLOOR

for shipwrecks and sunken gold. Nautilus Minerals is after more abundant oceanic treasure – and it has three mammoth machines to help. “Mineral deposits found on the sea floor – copper, nickel, cobalt, gold and zinc – tend to be present in much higher grades than on land,” explains Mike Johnston, CEO of the Toronto-based deep-sea mining company. Extracting them requires diving down into a high-pressure, pitch black, often volcanic environment, but for Johnston, the prize is worth the risk. “The average grade of copper ore mined in an open pit is

032 / START / SHOCK AND ORE

MONSTER OF THE DEEP

Extracting minerals from the seabed is a dangerous business – so this 250-tonne digger comes in handy

about 0.6 per cent,” he says, “but on the sea floor we’ve found about eight per cent.” Higher-grade ores mean less rock needs to be dug up, thus reducing toxic waste from extracting metals from the ore, which is typically stored in enormous dams called tailings. “These do fail, and it tends to happen around every five years,” says Johnston. “With our project the ore is so high grade everything can be extracted without producing any tailings at all.”

Undersea minerals appear in two forms: as sulphide deposits where gaps between tectonic plates vent hot metals into the ocean, as at Nautilus’s Papua New Guinea site, Solwara 1; and as fields of potato-sized nodules laying deep in the middle of oceans, formed by the precipitation of metals from seawater over millions of years. “The area of the central Pacific covered by these minerals is approximately the same size as the United

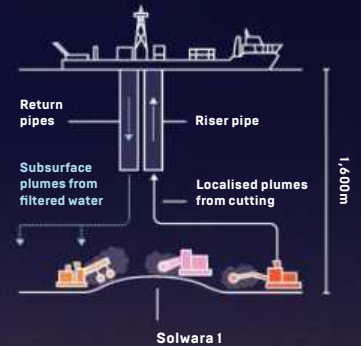
States,” says Johnston. “There’s enough copper already known here to provide for our next 30 years of consumption worldwide.”

Solwara 1 is first on the agenda. Nautilus has secured mining rights to the 1,600-metre-deep site and took delivery of its first three mining machines in February 2016. Mining of the site’s estimated one million tonnes of mineral ore is intended to begin in 2018. “A lot of people will be watching the first one, to see how this will work,” says Johnston. “We can show them models and consultant reports, but there’s nothing like actually doing it.” **Kathryn Nave** nautilusminerals.com

HOW TO MINE THE OCEAN FLOOR

The **auxiliary cutter** clears ridges in the seabed to prepare for mining. Then the **bulk cutter** breaks up larger chunks of material, before a **collecting**

machine (main picture) draws up the material as a slurry into the riser and lifting system, where solids and liquids are separated.



THIS IS YOUR LIFE.

BE A **HERO**



TOMASZ FURMANEK
Photo by: Tomasz Furmanek

GoPro
Be a **HERO**.



OVER **60** MOUNTS +
ACCESSORIES

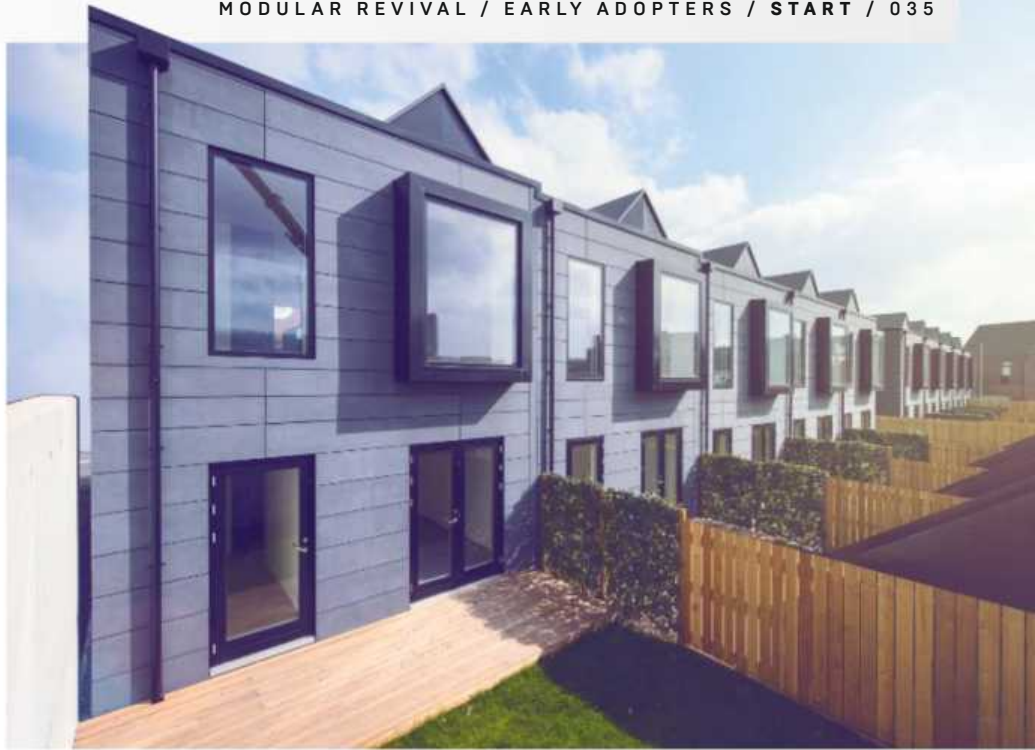


CREATE + SHARE
GOPRO APP

#BEAHERO

HOME DELIVERY SERVICE

Shedkm wants to remedy the UK housing shortage – by building and shipping your home within 21 days



H

HOW DO YOU CONSTRUCT A CUSTOM-BUILT TERRACED HOUSE IN THREE WEEKS?

Swap traditional materials such as bricks and mortar for prefabricated wooden frames that can be slotted into place. London- and Liverpool-based architects shedkm used the technique for a new terraced block of 43 “hoUSes” (above) in Manchester, teaming up with developer Urban Splash and timber-panel company Insulshell to prefabricate walls, ceilings and floors. “The construction method uses existing timber technologies, but combines them in a new way,” says Ian Killick, director of shedkm.

The company made each storey as a rigid six-sided box, meaning each unit was self-supporting. The boxes were transported to the site in New Islington, Manchester, for the March 2016 opening. Each box for the dwellings, which cost from £100,000 to build, took eight weeks to fabricate in Insulshell’s factory.

Now, shedkm is constructing 800 houses in Tyne and Wear, finishing in September – and Insulshell has introduced a production-line system which will cut its current build time of eight weeks to three weeks. “Transportation is key to building in this way,” says Killick. “At present there is a limited number of the right sort of vehicles, but that should change as demand increases. The sight of housing modules moving around our motorway network will become commonplace.” **Clare Dowdy** shedkm.co.uk

Buyers can customise their 140m² house by adding internal walls or choosing whether sleeping quarters are on the ground or upper floors



EARLY ADOPTERS

WHAT'S EXCITING...

RACHEL COLDICUTT

Director of products and services, **Doteveryone**



“I haven’t found a good bookmarks and reading-list manager since I stopped using Delicious. Kifi has tools to build collaborative and searchable lists of links, so I can keep references and reread things that people have recommended. It’s nice to feel all the things I’m reading are building into a coherent list that I can go back to and explore.”

WHAT'S EXCITING...

ROBYN EXTON

Founder, **HER**



“One of my favourite startups in the world is **Founders Pledge**. It works with entrepreneurs around the world to commit to donating to a social cause should they exit their companies. It not only helps these founders commit, it also helps advise on how to donate money to the right organisations in the right way.”

WHAT'S EXCITING...

MARY FITZGERALD

Editor-in-chief, **openDemocracy**



“I’m useless at keeping receipts and doing my expenses, so I use **Curve**, an all-in-one debit/credit/payment card. You upload your cards and choose which one to want to charge when you pay for things. If you’re abroad it gives a super-low exchange rate, and – best for me – it lets you track your expenses on the go.” **PB**

WHAT NEW TECHNIQUES WILL SPY AGENCIES BE USING IN TEN YEARS' TIME?

ANNIE MACHON

JOURNALIST;
MI5 WHISTLEBLOWER

"Algorithms will scan images to predict if someone is acting dangerously. Interconnected with Facebook recognition, phone tracking and CCTV networks, this tech may help intelligence agencies identify you in real time and follow you. That might catch a few people – but I doubt it. The margin of error is so great. And it's already being used: during the 2011 royal wedding, known activists were pre-emptively arrested for 24 hours, based on what they'd said on Facebook. Once you link all the technologies, you very quickly get to an Orwellian state." **PB**



KEREN ELAZARI

SNR RESEARCHER, BLAVATNIK INTERDISCIPLINARY CYBER RESEARCH CENTER, TEL AVIV UNIVERSITY

"The new spy will be less James Bond, more data scientist. Supercomputers and artificial intelligence will use distributed computing models to identify patterns in unstructured data. Nanobots with sensors will track organic and chemical compounds. Intelligence agencies will remotely manipulate satellites and fully autonomous cyberattack drones will use digital tools to disrupt communications."



NEIL RICHARDS

PRIVACY LAW PROFESSOR, WASHINGTON UNIVERSITY SCHOOL OF LAW

"Connected objects will have voice interfaces that allow you to speak commands. But for them to work, they need to be listening. These technologies will be a treasure trove of data for our security services, turning your internet of things into an internet of spies. In the future, you'll have to worry as much about whether you can trust the discretion of your kettle as about whether someone is listening when you're on the phone."



ERIC BYRES

SENIOR VICE PRESIDENT, ICS SECURE

"There is a move from espionage threats against the IT and intelligence systems to economic and political threats against our infrastructure. Cyberattacks we see now against physical systems are 'advanced persistent threats', created by their handlers with a long-term set of objectives or political agendas. The mistakes we are making today may not be exploited for years, but they will be exploited some day."



INDY DHAMI

DIRECTOR OF CYBERSECURITY CONSULTING, CRYPTA LABS

"Agencies' use of Stuxnet-type worms – similar to those that sabotaged Iran's nuclear activities – could be part of both intelligence and war programmes. These would infiltrate critical infrastructure to facilitate attacks. AI may be used to predict crime by identifying patterns in data based on historical elements. This can include data from censuses, locations of nightclubs, religious centres, stadiums, schools, etc."

'IN THE FUTURE, YOU'LL HAVE TO WORRY AS MUCH ABOUT WHETHER YOU CAN TRUST THE DISCRETION OF YOUR KETTLE AS ABOUT WHETHER SOMEONE IS LISTENING WHEN YOU'RE ON THE PHONE' NEIL RICHARDS



This cloud opens doors of opportunity.

The Microsoft Cloud has helped Temenos lower the cost of borrowing by 90%. By putting their core banking software in the cloud, microfinance institutions are able to reduce the need for infrastructure and management. In turn, this opens the doors of opportunity for millions of underbanked people all over the globe.

This is the Microsoft Cloud.

DON'T FIND STARTUPS: INVENT THEM

Entrepreneur First turns techies
into founders within six months

H

OW DOES AN ACCELERATOR SOURCE HIGH-QUALITY STARTUPS?

At Entrepreneur First (EF), it simply builds them in-house. Since 2011, the London-based investment programme has launched 75 companies that have since gone on to raise \$100 million (£70m) in venture capital funding. But where most investors look for startups with plans and people in place, EF begins with individuals – pre-team, pre-idea, winnowing down the most promising from as many as 1,000 applicants. “They have some of the best technologists,” says Wendy Tan White, co-founder of DIY website builder Moonfruit, who joined EF in 2015 to manage the fund. (White, who sold Moonfruit in 2012 for a reported £23m, is raising £40m to extend the six-month EF process to a year.) “This is not a normal fund. It’s a company builder.”

EF begins with three months of team building and idea development, during which participants are paid a stipend of £1,200 a month. After this phase, EF co-founders Alice Bentinck and Matt Clifford, both 30, decide whether or not to take a seven per cent equity stake in a few of the newly formed companies, providing successful teams with another £10,000 to help them through to Demo Day. To encourage substantial, money-making propositions, the pair get participants to focus on their “edge” – a competitive advantage, usually a technical skill. “The status quo is to solve a problem you’ve experi-

enced, but that leads to people solving small, trivial problems,” says Bentinck. EF companies don’t build dating apps or social networks for pets, but “unsexy, enterprise things”: in the most recent, fifth cohort, 20 of the 25 graduating companies were B2B and 15 were working on a branch of artificial intelligence.

The EF process is not infallible – at last count, 27 per cent of participants failed to make it to Demo Day – but Bentinck and Clifford, who set up a branch of EF in Singapore in January 2016, believe that in the competitive world of venture capital, the best way to discover startups is to make them yourself. “It’s like *The X Factor* without the tears,” Bentinck says. “Most of the time...” RM.joinef.com

ENTREPRENEUR FIRST AND A FEW OF ITS ALUMNI (Back row)

Theo Saville, co-founder and CEO, CloudNC;

Chris Emery, co-founder and CTO, CloudNC;

Katarzyna Streich, co-founder, Hypermetric;

Razvan Ranca, co-founder, Tractable;

Adit Trivedi, co-founder and CTO, Lingumi;

Joe Root, co-founder and CTO, Permutive;

Joe White, general partner, EF

(Front row)

Matt Clifford, CEO of EF;

Toby Mather, co-founder and CEO, Lingumi;

Alice Bentinck, co-founder, EF;

Vivian Chan, CEO, Sparrho;

Jesse Lozano, co-founder and CEO, Pi-Top;

Rafael Jorda Siquier, founder and CEO, Open Cosmos;

Wendy Tan White, general partner, EF;

Phoebe Hugh, co-founder, Brolly





This cloud redefines winning.

The Microsoft Cloud gives Special Olympics instant access to key performance and health data for every athlete, no matter where they are. Microsoft Azure and Office 365 help streamline the management of 94,000 events across 170 countries each year. So the focus can be on changing the lives of athletes, and that's the true victory.

This is the Microsoft Cloud.

learn more at microsoftcloud.com

 **Microsoft Cloud**



EUROPE'S BIG EYE ON DEEP SPACE

Thanks to Ireland's low levels of radio interference, the world's largest telescope just got bigger

THE BIGGEST TELESCOPE IN THE world is getting an extension in Ireland. That's the location of the latest station in LOFAR, a network of high-resolution radio antennae that forms a telescope stretching across Europe. "LOFAR spans 1,900km, from southern Poland to central Ireland. It's the largest telescope in the world," says Peter Gallagher, professor of astrophysics at Trinity College Dublin, and head of the Irish consortium for LOFAR, which stands for "Low-Frequency Array".

The football-field-sized Irish station will extend the range of the 50-site

LOFAR by 30 per cent. All the stations in the 10,000-antenna network transmit their data back to LOFAR's processing centre in Exloo in the Netherlands (*above*), where the signals are combined to create a high-resolution image of the sky. "LOFAR will allow us to study star formations, exoplanets, solar physics, magnetic fields and the early universe," says Gallagher, 42. Dutch-led LOFAR was set up in 2010 to monitor radio frequencies below 250 megahertz, but astronomers have recently discovered it can also function as a particle detector.

Located at Birr Castle in County Offaly, home of the Leviathan telescope in the 1840s, the Irish LOFAR station will benefit from the site's low level of radio-frequency interference, says Gallagher. The station, which is funded by a €1.4 million (£1.1m) award from the Science Foundation Ireland, philanthropic grants and private donations, is due to be completed in spring 2017. Italy, Latvia and Bulgaria are also looking into opening stations. "One country couldn't have done it," Gallagher says. "Many nations together can do so much more." **PB** lofar.ie

PHOTOGRAPHY: ASTRON

Meet Olivia, your virtual nurse. Developed by San Francisco-based startup Sensely, the avatar can make a diagnosis, advise on treatment and schedule an appointment – all in what Sensely co-founder Ivana Schnur describes as "an old-fashioned bedside manner". Created in 2013 for use in the US – where Olivia is known as Molly – the system is undergoing a six-month UK trial by the groups in charge of West Midlands III, the NHS service for non-emergency calls. With machine-learning startups such as Your.MD and Babylon working on similar services, this kind of symptom-checking could solve the problem of over-stretched emergency rooms. **RM** sense.ly

ILL? ASK AN
AESCULAPIAN
ALGORITHM





This cloud stands up to any storm.

Microsoft Azure scales to enable AccuWeather to respond to 10 billion requests for crucial weather data per day. This cloud rises to the challenge when the weather is at its worst.

This is the Microsoft Cloud.

learn more at microsoftcloud.com

 Microsoft Cloud



HA-2

EUROPEAN HI-FI USB DAC/HEADPHONE
AMPLIFIER OF THE YEAR 2015-2016

HA-2 is a compact headphone amplifier and USB DAC featuring ESS Sabre¹² Reference ES 9018-K2M DAC chip and support for 384 kHz/32-bit PCM and DSD up to 11.2MHz



“HA-2 is the smart choice for those seeking a polished-sounding and gutsy performer that's keenly priced.”

“For £250, you'll struggle to find better detail or dynamics from a headphone amplifier and USB DAC.”

“A gem of a headphone amp/DAC at a very competitive price. Deserves to win plenty of friends.”

“It's this combination of power and finesse that's so alluring in something so affordably priced.”

“...a crushingly competent piece of equipment for the asking price.”

oppo

oppodigital.co.uk/where-to-buy



YOUR FAST PERSONAL SHOPPER

Robin Chan's Operator does your shopping on demand. Not surprising, considering its close Uber connections

OBIN CHAN'S

"operators" will find anything you want – all you have to do is drop them a text. "If you say, 'I'm looking for a leather sofa,' we take your request, in text form or a photo, identify that you're looking for furniture and connect you to a furniture expert," explains Chan, Operator's co-founder and CEO (pictured). Your new helper will research and recommend an item, and, if you buy it, arrange delivery – an exchange that takes place entirely via chat on the *Operator* iOS app [or, since April, in Facebook Messenger]. "Messaging apps are now bigger than browsers," says Chan. "If the internet's going to look like a conversation, commerce should be completely rethought."

Chan, 38, an angel investor with early wins in Twitter, Square and Xiaomi, developed the idea in 2013 with Uber co-founder Garrett Camp. "We saw a need to create a new type of routing system between

people who needed stuff and people on the other end who could solve their problem," he says. After two years in Camp's startup studio Expa, the pair launched Operator together in November 2015. The Uber connections continue: Camp is on Operator's board, and last December Operator partnered with UberRUSH for delivery of Christmas presents from two department stores in San Francisco.

"There's [now] a logistics layer at the local level that allows you to move goods," says Chan. And that layer is Uber.

Operator has raised \$10 million (£6.9m) in funding. Chan says there are "many business models", from advertising to taking a percentage of the sale. Looking ahead, he sees Operator's future lying with AI – the app currently uses bots to connect shoppers to experts, but the whole system could be operated that way. For now, however, the goal is growth. "The key thing is for us to scale this whole system," he says. "I imagine Uber's thinking the same thing." Adam Born operator.com



Events, new products and promotions to live the WIRED life

Compiled by
Cleo McGee



1/Prada Luna Rossa Eau Sport mens' scent

The combination of bergamot, cedarwood, ginger and grey amber makes for a sharp, sleekly sophisticated scent that packs a punch. The sporty vibe is mirrored in Prada's bottle shape, with clean lines and a clear flacon embossed with the red Prada tag. Neat and smart. **£55 (75ml)**
selfridges.com

2/Tumi Tahoe carry-on travellers' case

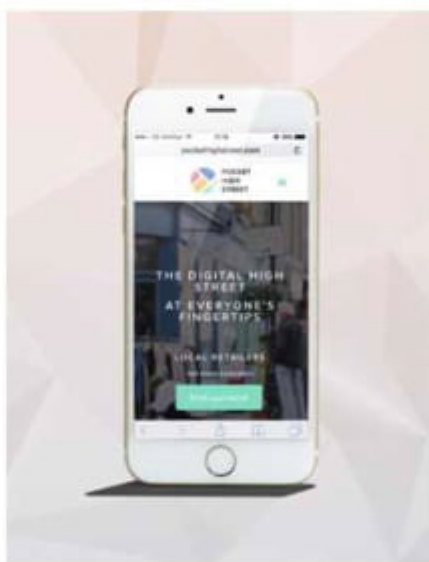
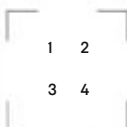
This Tumi case is practical, durable and stylish, and can be wheeled or carried. The Tahoe collection is based on the colours of Sierra Nevada's Lake Tahoe. Its water resistant fabric and lightweight structure makes this the sensible choice for the trendy, always prepared traveller. **£595**
uk.tumi.com

3/Havaianas Flat Sunset beach sandals

This brand of flip-flops has been busy producing a huge array of colours and styles – including a Liberty print range. We love these sunset colours that evoke the hues of summer. Practical and on trend, they will suit anyone looking for the perfect beach footwear – male or female. **£20**
havaianas-store.com/en

4/Pockethighstreet smartphone app

This app promotes local businesses by letting you purchase from nearby shops, delivering straight to your door within an hour. Their up to date inventory means you can shop online and promote local goods and services. The service also rewards bloggers for contributions. **Free**
pockethighstreet.com



WIRED INSIDER'S PICK OF UPCOMING EVENTS

WIRED 2016

This is our flagship two-day event. Hosted at London's Tobacco Dock, it gathers a myriad of speakers to talk on all topics impacting the WIRED world. The agenda will be shaped by WIRED's editor David Rowan and the editorial team. Previous speakers include, will.i.am, North Korea defector Hyonso Lee, Björk, late architect Zaha Hadid and Martha Lane Fox. There will also be a large Test Lab exhibition, where attendees can try the latest technology products. Virtual Reality experiences are always popular and evolving constantly. See the WIRED brand brought to life in a tangible and engaging way. Not to be missed. **November 4-5, 2016**
wired.co.uk/2016

WIRED RETAIL

Exploring the future of Retail in both the digital and physical spaces, this one-day event will impart an understanding of the ways in which digital is impacting the retail space. Topics span frictionless payments, virtual reality, 3D printing, drone delivery, the blockchain and personalisation. Previous speakers include Uber's Jo Bertram, Lyst's Chris Morton, and Instagram's Tracy Yaverbaun. The day, with Main Stage talks, Startup Stage pitches and dedicated networking sessions, also has a Test Lab exhibition so delegates can get hands-on with the tech changing the retail landscape. **November 16, 2016**
wired.co.uk/retail16

Follow us on Twitter and Instagram:
@WIREDINSIDERUK



IDEAS BANK

Automation has today penetrated

nearly every aspect of our lives. Most of us now drive cars equipped with computers that automatically engage the brakes and reduce transmission power, often so subtly we don't notice the vehicle has anticipated our tendency to over-correct. We work in offices where customers are routed to departments via phone systems, emails are automatically sent when we're away from our desks and bank accounts are instantaneously hedged against currency fluctuations. We communicate with smartphones that finish our words. But even without technology's help, all humans rely on cognitive automations, known as heuristics, that allow us to multitask. Mental automation lets us choose, almost subconsciously, what to pay attention to and what to ignore. These automations have made factories safer, offices more efficient, cars less accident-prone and economies more stable. By one measure, there have been more gains in the past 50 years than in two previous centuries combined, much of it made possible by automation.

But as automation becomes more common, the risk that our attention spans will fail has risen. Studies show errors are more likely when people are forced to toggle between automaticity and focus. In the age of automation, knowing how to manage your focus is more critical than ever. The reliance on automation can result in an increase in cases known as "cognitive tunnelling" – a glitch that occurs when our brains are forced to transition abruptly from relaxed to panicked attention.

"You can think about your brain's attention span like a spotlight that can go wide and diffused, or tight and focused," says David Strayer, a cognitive psychologist at the University of Utah. When we allow automated systems, such as computers or autopilots, to pay attention for us, our brains dim that spotlight and allow it

CHARLES DUHIGG

COMPUTER SAYS: STOP RELYING ON THE COMPUTER

to swing wherever it wants, helping us subconsciously to control stress levels, meaning we don't have to constantly monitor our environment. "But then, bam! Some kind of emergency happens and the spotlight in your head has to ramp up all of a sudden and, at first, it doesn't know where to shine."

Cognitive tunnelling can cause people to become overly focused on what is in front of their eyes or become preoccupied with immediate tasks. Once in a cognitive tunnel, we lose our ability to direct our focus. Instead, we latch on to the easiest and most obvious stimulus, often at the cost of common sense. "These technologies are supposed to make driving safer... but it also makes reactive thinking easier, so when the unexpected happens you'll react with practised, habitual responses," says Strayer. "Instead of



Charles Duhigg

is author of *Smarter Faster Better*

(William Heinemann)

thinking, you react, and if it's not the correct response, bad things happen."

An example of such behaviour led to the fatal crash of the Air France Flight 447 on June 1, 2009. A pilot was shaken from his reverie when alarms sounded after the plane's pitot tubes – which measure airspeed by detecting the force of air flowing into them – became clogged with ice crystals. This set off a series of events which were compounded by the pilot's cognitive tunnelling, focusing on what he perceived to be the immediate solution and neglecting his surroundings which were presenting all the information necessary to right the plane.

A means of combating such misplaced focus is through creating mental models. Understanding how people build mental models has become one of the most important topics in cognitive psychology. All people rely on mental models to some degree. We all tell ourselves stories about how the world works, whether we realise we're doing it or not.

So what's the solution? If you want to do a better job of paying attention to what really matters, of not getting overwhelmed and distracted by the constant flow of emails, conversations and interruptions that are part of everyday life, get into the habit of telling yourself stories. Narrate your life as it's occurring, and then, when your boss suddenly asks you a question, or when an urgent note arrives and you have only minutes to reply, the spotlight inside your head will be ready to shine the right way.

To become productive, we must take control of our attention; we must build mental models that put us in charge. When you're driving to work, force yourself to envision your day. While you're sitting in a meeting or at lunch, describe to yourself what you're seeing and what it means. Find other people to hear your theories and challenge them. Get in a pattern of forcing yourself to anticipate what's next.



RICK SHENKMAN

WE KNOW HOW YOU'LL BE VOTING

In 2004, in the US, countless members of the Democratic Party fell in love. The object of their affection was a young man with a beautiful face, large eyes and a winning smile. His name was John Edwards. Though he had been in national politics barely five years and had no accomplishments to speak of, he went on to become the Democratic Party nominee for vice president. What accounted for his sudden success? The cheeky answer would be that Americans are superficial and judge politicians by their looks, which in this case proved palpably misguided. As you may recall, while Edwards was celebrated for his marriage to a down-to-earth, middle-aged lawyer, he was cheating on the side with a younger beauty whom he had put on his campaign payroll.

Studies in the US do indeed suggest that American voters frequently choose candidates on their looks. That seems to be the implication of a 2006 study involving Harvard students who were asked to evaluate politicians running for governor strictly on the basis of a silent ten-second video clip. The experiment, conducted by Daniel J Benjamin and Jesse M Shapiro, showed astounding results. Fifty-eight per cent of the students picked the candidate who would go on to win. This suggests that many voters are doing exactly what these students were: judging the candidates by their looks. In a second study published a year later by Alexander Todorov, this time involving Princeton students, the results were even starker. Rather than being shown video clips, the students were briefly exposed to candidates' headshots. Once again the students showed no reluctance to draw inferences about politicians from their image alone. And once again they showed an uncanny ability to pick the candidates who

went on to win. (They chose those who looked the most competent.)

But it is not just Americans who let a candidate's appearance affect their vote. Social scientists report that this is common around the world. A study of British voters in non-partisan community elections found that they overwhelmingly went for the candidates whose pictures neutral observers rated trustworthy, empathic and competent. (You can Google the study: "Looking Like a Winner: Candidate Appearance and Electoral Success in New Democracies".)

Worse, when British students at the University of Liverpool were asked to select candidates on the basis of the shape of their faces alone so the identity of the candidates – George W Bush and John Kerry – could not be determined, they chose Bush just as American voters had. Why? It was apparently because Bush had a more masculine face. The researchers found that voters, whether British or American, prefer politicians with classic masculine features in wartime (the study was conducted at the height of the Iraq War) and classic feminine features in peacetime. (The study, "Facial Appearance Affects Voting Decisions", wasn't a hit job on the British by Americans. It was conducted by UK researchers.)

Why do humans draw inferences from such obviously superficial



Rick Shenkman is the publisher of the History News Network and the author of *Political Animals: How Our Stone-Age Brain Gets in the Way of Smart Politics* (Basic Books)

criteria as an individual's facial contours? Evolutionary psychologists say the answer is that during the Stone Age, the two-and-a-half-million year-long period when the human brain mainly evolved, lightning-quick judgements often had to be made about strangers. Nature rewarded those who could estimate at a glance whether someone else was competent, empathic or a threat. Those who proved good at the task were more likely to survive and pass along their genes, enhancing their fitness, as evolutionary scientists put it.

Just how quickly do we make these judgements? In one 2005 study, "Inferences of Competence from Faces Predict Election Outcomes", published by the American Association for the Advancement of Science, it was established that our snap judgements about people take shape within 167 milliseconds of seeing them – that's faster than it takes to blink. When subjects in experiments are given more time to make a decision, they use it merely to become more confident that their initial impression was correct. They don't rethink their decision. All of this takes place largely outside of conscious awareness. In other words, your brain makes up its mind about someone you meet in less time than it would take you to shake their hand.

Knowledgeable voters base their decisions on more than the snap judgements that their brain makes. But most voters aren't knowledgeable. You can keep that in mind the next time an election goes against your candidate. You can legitimately comfort yourself with the thought that the voters knew not what they were doing.



A

According to the Office of the United Nations High Commissioner for Refugees (UNHCR), more than 4.8 million people have fled Syria alone since the outbreak of civil war in 2011. In 2015, Amnesty International reported that the total number of refugees worldwide reached nearly 20 million. When including the number of displacements within countries, the number climbs to 60 million.

Such numbers may appear to be a crippling crisis for many governments and NGOs – but they may be an opportunity for businesses and startups.

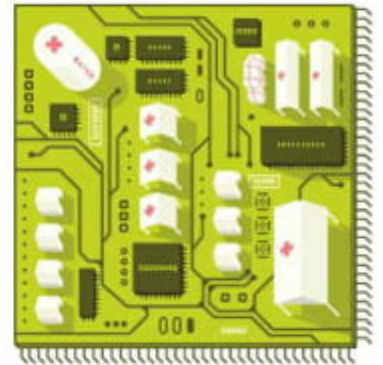
Refugees looking for shelter away from areas of conflict often live in appalling conditions, with minimal access to food, water or healthcare. Meanwhile, others who do find a new home often lack access to information, education and entertainment, among other basic needs. But it doesn't need to be this way. With the rapid growth in exponential technologies (3D printing, AI, etc), we have the tools to create sustainable solutions.

At Singularity University (SU) in Silicon Valley, we provide educational programmes, innovative partnerships and a startup accelerator to help individuals, businesses, NGOs and governments understand cutting-edge technologies, and how to utilise these technologies to positively impact billions of people. And in collaboration with our international partners, including Amnesty International, UNICEF and Doctors Without Borders, many ideas have been put into action.

What started from a passion for shipping containers grew in just six weeks into the Refugee First Response Center, a place that provides medical assistance, free Wi-Fi and translation services for 50+ languages. Created by Singularity University Alumni Harald Neidhardt (MLOVE) and Mirko Bass (Cisco), the two leveraged their Hamburg network to create provide medical services at refugee camps, where it is most needed.

PETER DIAMANDIS

EXPONENTIAL THINKING IS READY TO TRANSFORM REFUGEES' LIVES



X²AI, founded by Eugene Bann (UK) and Michiel Rauws (The Netherlands) in 2015, delivers mental health services, communication and emotional well-being to refugees via an AI bot named Karim. The founders came to the Singularity University Accelerator programme in 2016 and recently returned from a pilot in Beirut.

Matternet, a drone delivery startup aimed at providing logistics in remote areas, can transport diagnostic tools and medical supplies to those who need it, often in very hard to reach areas. The company has started with pilot projects in Haiti and Bhutan, and is currently working on a safe, cheap and easy to use delivery service. It began under Andreas Raptopoulos (Greece) in SU's Global Solutions Program as a summer project.

SingularityU The Netherlands, selected as the first Exponential Regional Partner for Singularity University, is also recognising the need for immediate action. As its first initiative, SingularityU The Netherlands launched a Global Impact Competition aimed at leveraging technology to create a better life for refugees. The winner, who will have been selected by the time you read this, will attend the ten-week SU

Global Solution Program this summer and has the opportunity to further develop their project, supported by the SU global community.

UNHCR has been working with refugees for more than 60 years, telling their stories and assessing and meeting their needs. It recognises that enabling refugees to live in communities lawfully, peacefully and without harassment supports their ability to take responsibility for their lives and communities. Refugees bring personal skills and assets which can benefit the communities where they are living. They also bring the qualities of perseverance, flexibility and adaptability.

I recently hosted Melissa Fleming, the UNHCR's head of communications, and her comments are highly relevant: "There is more that we can do than just simply help refugees survive. We can help them thrive. We should think of refugee camps and communities as more than just temporary population centres where people languish waiting for the war to end. Rather, we can envision them as centres of excellence, where refugees can triumph over their trauma and train for the day that they can go home as agents of positive change and social transformation." This is our goal. Join us. global.singularityu.org/gic



Peter Diamandis is co-founder and executive chairman of Singularity University, founder and chair of the XPRIZE Foundation, and co-author of *Bold* (Simon & Schuster International)

ANGELA DUCKWORTH

VOCATIONS START AS VACATIONS

T

he other day, a friend said that the US is the grittiest country in the world.

Is it? Is there a surplus in the US of passion and perseverance for long-term goals? Should we be exporting our culture of grit to other countries?

"Americans work long hours and take little time off for vacation," she said. "So, we must be the grittiest."

If grit is keeping your nose to the grindstone – any grindstone – then there is a case to be made for Americans topping the international grit charts. One of the items on the scale I've developed to measure grit asks how much you identify with the statement "I am a hard worker". And workers in the US log more hours per year than their counterparts in the UK, Germany, France, Japan and many other industrialised countries. American workers also take fewer days of paid vacation.

There are other items on the Grit Scale, because grit and grind are different. If you work like a dog but find zero joy or meaning in your toil, you're not gritty. In other words, if your long hours are an uninvited burden – if you're making a living but lack a long-term goal you're intrinsically motivated to accomplish – then you're not gritty, either.

Working hard is only part of grit. "Tiger mother" Amy Chua suggests that for lack of hard work "most people stink at things they love". After studying grit for over 12 years, I can tell you that exalting only long hours isn't the right message, either.

I've interviewed paragons of grit in industry, public service, scholarship, sports and the arts. Many work almost twice the hours their colleagues do. Not a single one said they felt compelled by outside forces to do so.

Instead, the truly gritty are driven by two intrinsic motivations: interest and purpose. They're fascinated by their work, and they appreciate its importance to others. My work is my calling, they tell me. I love what I do!

If grit minus passion equals grind, then what should parents, managers and coaches do? Should we teach perseverance and assume passion will follow?

One argument for encouraging perseverance is that the sort of hard work that is really known to boost performance – what scientists call deliberate practice – is typically experienced as extremely effortful and, to varying degrees, unenjoyable.

As Olympic gold medalist Rowdy Gaines put it, swimming the equivalent of the circumference of the globe in preparation for a 100-metre race that would last well under a minute was not what kept him in the sport. He had a passion for competing, for being in top condition, for the sport of swimming and the camaraderie of his teammates. On a good day, practice was satisfying. But as an experience, it wasn't nearly as pleasurable as countless other ways Gaines could have spent his time.

So it stands to reason that, left completely to our own devices, few of



Angela Duckworth
is the author of
*Grit: The Power
of Passion and
Perseverance*
(Vermilion)

us will learn to work as hard as we need to work to really get better – at anything.

Another argument for emphasising perseverance is that the short-term rewards of giving up on hard things loom large when we're discouraged. When we give up – quitting the team after being on the bench most of the season, or neglecting our New Year's resolutions – we feel better. We're no longer confused, insecure or disappointed. Lowering standards is the quickest and surest way to meet expectations.

Legendary NFL quarterback Steve Young recalls calling home during his first semester. "I'm just a big tackling dummy for the defence," he told his dad. Indeed, Young was the eighth-string and his primary function was to help the starting defensive line practise their plays. "This is not what I expected... and I think I'd like to come home."

"You can quit," Young's dad said, knowing that the temptation to quit on a bad day is strong, and that sometimes you need someone who loves you to prevent you making a rash decision. "But you can't come home because I won't live with a quitter." Young stayed. His dad, who in his youth earned the nickname "Grit", later introduced Young at his induction to the Football Hall of Fame.

Thirty years ago, psychologist Benjamin Bloom interviewed 120 world-class performers in maths, neuroscience, swimming, tennis, piano and sculpture. Most said their expertise was from years of skill-building practice.

But before practice came play. Almost all described falling in love with their vocation, during what Bloom called "the early years", during which they engaged in their calling somewhat casually, with minimal focus on improving weaknesses and maximal focus on enjoyment and interest. They practised, but not with the intensity that would come later.

Sports psychologist Jean Côté finds the same pattern in pro athletes: those who start out playing for fun, dabbling in a few sports rather than pursuing one, tend to avoid injury and burnout.

Should young people learn to work hard? I think so. Do they need an occasional nag? Do they benefit from a strict coach, teacher, boss or parent to bring forth their best effort? Absolutely.

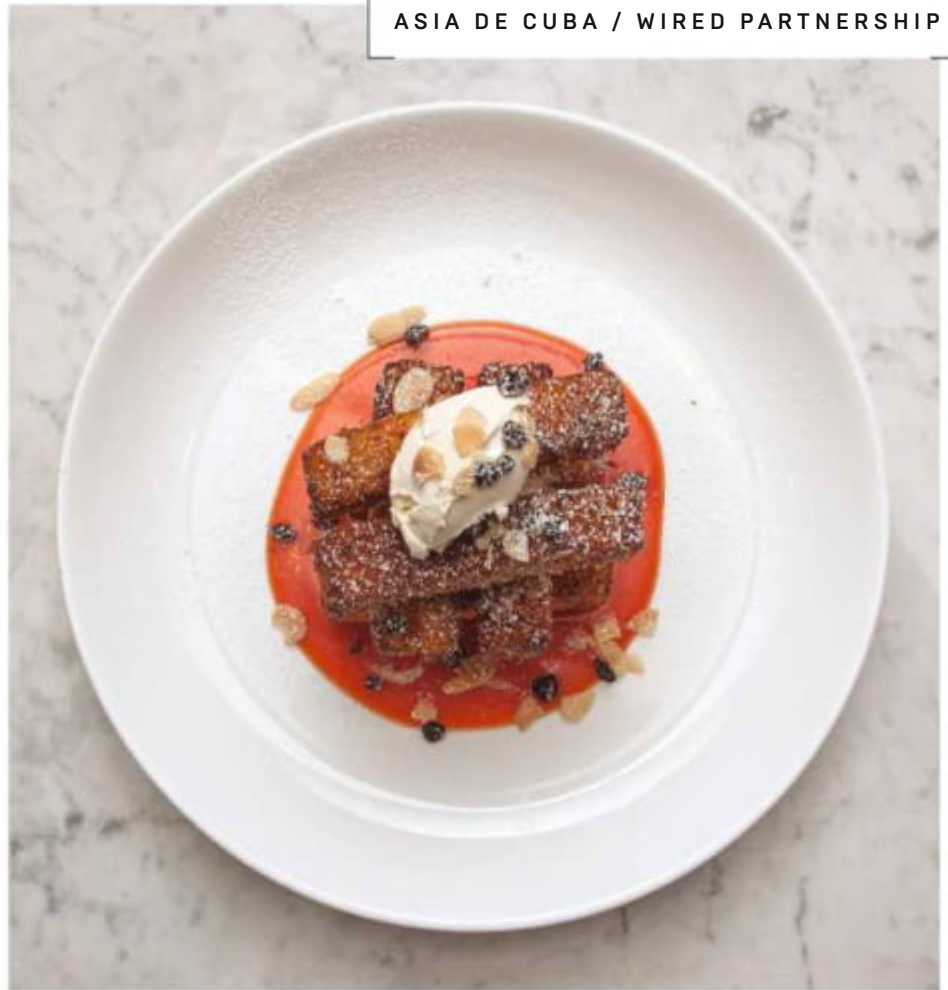
But in the virtuous cycle of passion leading to perseverance that in turn leads to even greater passion and so on, I submit that we should let the spark of passion come first.



To keep up with London's ever-changing food scene – and thrive while doing so – is no mean feat. This, however, continues to be the norm for one of the capital's most experimental and experiential culinary spots – Covent Garden's Asia de Cuba at St Martins Lane Hotel. Suitably, executive chef Luis Pous has made its menu far from predictable. Daring combinations and modern twists on traditional dishes create a fusion of Asian-inspired Cuban cuisine – a unique interpretation created to showcase what might have come out of the Cuban island, had its native chefs had greater access to ingredients over the past half-century.

More recently, Pous has chosen to focus on that New York favourite – the bottomless brunch. In keeping with restaurant founder Jeffrey Chodorow's original vision, the three-course sitting is available as a Cocktail Brunch, consisting of unlimited mojitos, mimosas, bellinis or bloody marys, at £48 per person; or the more celebratory Champagne Brunch – with unlimited Perrier-Jouët – at £70 per person.

In true Cuban fashion, the brunch dishes are made to share. But diners also get to choose one of the signature main course dishes from Asia de



MEET THE HYBRID BRUNCH

A STANDARD MENU, THIS IS NOT. THE CHINO LATINO BRUNCH AT ASIA DE CUBA IS BUILT FOR SHARED FUN AND INDIVIDUAL DECADENCE

Cuban toast and crispy brioche rolled in coconut and almonds

Cuba's à la carte menu – each with an authentic pan-Asian twist.

To finish the feast, bottomless brunchers are presented with an unlimited serving of Asia de Cuba's Mexican doughnuts – with either caramel or Thai chilli-chocolate dip – and gives a sumptuous finishing note. The only decision left will be whether to return to the office.

For more, see asiadecuba.com

STEP THIS WAY

Whether diners are looking for an intimate dinner venue or the starting point for a celebratory night on the town, Asia de Cuba – at the heart of the capital's theatre district in Covent Garden

– prides itself on the unique. With a rebooted menu, its doors were re-opened in April 2015. Its menu spans ceviche, salads, sides and a selection of intriguing meat, seafood and vegetarian dishes.



A stone's throw from London's Chinatown, Asia de Cuba fittingly pays homage to Havana, Cuba – itself the home of one of Latin America's oldest and largest Chinatown districts. Executive chef

Luis Pous peppers his menu with twists on Cuban classics, well-informed by his time training as a chef on the island. This is married with founder Jeffrey Chodorow's vision for a totally new type of cuisine.

Events, new products and promotions to live the WIRED life

Compiled by
Cleo McGee



1/Tile Gen 2 Bluetooth tracker

Tired of losing your keys or your phone? Tile is a compact Bluetooth tracking device that lets you track and search for tagged items via its app. It will call your phone for you if you have misplaced it, even if it is on silent. It also has a map feature, so you can retrace your steps.
£19.99
johnlewis.com

2/Withings Activité Steel watch

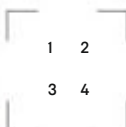
This sleek smartwatch is water resistant up to 50 atmospheres and comes with an activity tracking system for logging steps, distance, swimming, running and calories burned. It also features a sleep monitor – and all the data links to the companion smartphone app.
£139.95-£199.95
withings.com

3/Serapien Pochette handbag

Serapien has been crafting leather goods since the 1920s. This hand-crafted Milanese handbag is a timeless and elegant piece in a perfect summer-accessory colour. The leather is treated calfskin, making it scratch and water resistant, so it can be used for years to come.
£460
caseluggage.com

4/Jean Paul Gaultier Le Male eau Fraiche Popeye

The fragrance ships with a special Popeye edition this summer, complete with a "spinach" version of the Jean Paul Gaultier can. With scents of neroli, mint, sage and vanilla, this scent is simultaneously fresh and sweet. However, it won't give you the biceps of the sailor himself...
£49.99 (125ml)
theperfumeshop.com



WIRED INSIDER'S PICK OF UPCOMING EVENTS

WIRED MONEY

This event has an international agenda of 20 Main Stage speakers from more than ten countries, offering unparalleled insight into how this industry is changing. WIRED is pleased to announce the sessions, which cover: the new bank, reinventing insurance, democratising investing, designing efficiency, the rise of the machines, and the potential of the distributed network. In addition to the Main Stage speakers, we are proud to host the BBVA Open Talent Startup Stage, with more than 17 companies pitching their platforms to a judging panel.
June 23, 2016
wired.co.uk/money16

WIRED SECURITY

The newest addition to the WIRED annual events schedule is Security – a hot topic, as digital security and privacy are becoming increasingly important to businesses, governments and individuals. Industry experts and innovators will be speaking on the ways in which new thinking and technology will disrupt, challenge and help the industry. Business leaders, entrepreneurs, policymakers, investors and hackers will highlight converging trends and define the threats of the future – and our potential defences. A fascinating event on a critical digital topic.
October 19, 2016
wired.co.uk/security16

Follow us on Twitter and Instagram:
@WIREDINSIDERUK



WIRED is launching our first annual Innovation Awards, in partnership with Audi. Over the next few months we'll explore the nominations in each of the seven categories. To kick off, we highlight our first category: Innovation in AI

/ WIRED Audi /

INNOVATION AWARDS

Vorsprung durch Technik

Audi





Celebrating:
Innovation in AI
Most exciting moonshot
Innovation in experience design
Social innovation
Innovation in product design
Scientific breakthrough
Leadership in innovation

WIRED AUDI INNOVATION AWARDS

INTRODUCTION TO THE AWARDS

Admittedly, it's a somewhat overused term, but "innovation" is at the core of what's made the internet era so revolutionary. Smart thinking in technology, science, business, design and culture has defined the most recent two decades. And in reporting on innovation in these sectors, WIRED has discovered and explained many incredible stories.

WIRED is always on the lookout for the people, companies and ideas that have the power to change the world and society for the better. However, our celebration of such pioneers has historically been in the form of web stories, magazine articles, events or online video. This changes in 2016, with the launch of the WIRED Audi Innovation Awards – a new platform for WIRED to showcase the work of UK-based thinkers, makers and doers in each calendar year.

"It's a great opportunity to go beyond what we do in print and online by looking back at the best innovations in the last twelve months, and we're grateful to Audi for helping us do that," says WIRED's associate editor and awards curator Rowland Manthorpe.

"The strict definition of innovation is simply 'new things, put into practice' – but for me, innovation means so much more than that. It's the first glimpse of the future – an incredibly exciting place to be, as if the world is young and anything is possible."

There will be seven awards – with the nominations announced in this and the next three issues of WIRED. The categories cover hard science, product design and social innovation, to domains whose full potential we are only just starting to grasp, such as artificial intelligence and experience design (which includes

"The strict definition of innovation is simply "new things, put into practice" – but for me, innovation means so much more than that"

the blossoming fields of virtual and augmented reality). Visionary "moonshots" and lifelong innovation in leadership will also be rewarded.

"We're delighted to be a part of the WIRED Audi Innovation Awards," says Audi UK's Jane Bown. "Innovation is our lifeblood at Audi, and WIRED clearly shares our obsession with technology and its advancement, so for us there is no better partner with which to celebrate and bring to the fore the most inspirational innovators in the world right now."

We've contacted our extensive network for nominations in each category and have already had a huge response. The winners will be chosen by experts in each sector with the assistance of WIRED staff and Audi UK's representatives. The awards will be presented at a final ceremony in November.

WIRED readers will have their say, too. The winner of the most exciting moonshot category will be decided by public vote. Visit wired.co.uk and search #WiredAudiAwards for details on how you can help to decide what was Britain's boldest project in 2016.

1 2 3 4 5 6 7

Innovation in AI

Salvation or catastrophe? Whether you side with AI enthusiast Ray Kurzweil or with sceptic Stephen Hawking, there is little doubt that artificial intelligence is here, and its impact will be enormous. Powered by machine learning algorithms and big data, computers can now beat humans at video and board games, spot illnesses before symptoms appear and even think up tasty new recipes. 2016 was a seminal year for AI, especially in the UK – but which British individual, organisation or team really made a difference?

Most exciting moonshot

The term “moonshot” was first coined at X, skunkworks of Google umbrella company Alphabet, where self-driving cars, internet-providing blimps and Google Glass were dreamt up. Over time, the word has come to signify any bold, borderline-crazy attempt to solve big problems through science, technology and creativity. This award will celebrate British visionaries who in 2016 tried to radically change their sector – sometimes through unconventional means. WIRED readers will choose the winner through a public vote.

Experience design

Which British company managed to disrupt the way we experience the world in 2016? This award is for the creators of new feelings and sensations in art, culture, advertising and entertainment. And with a legion of much-awaited virtual reality headsets scheduled to debut this year, this category will also celebrate those inventors, teams or organisations that are already harnessing the potential of virtual and augmented reality to bring about change in their industries – from healthcare to entertainment.

Social innovation

Technology can help to change individual lives and whole societies – hopefully for the better. More and more big companies, states and individual innovators are using their creativity to find novel solutions to problems that might improve the lives of millions. These could be new physical products, digital tools or even far-reaching reform projects. Which British organisation, project or company found the most effective ways to harness technology for the greater good in the preceding year?

Product design

This award is for things that look great – and work even better. They could be new stunning appliances, a beautiful user interface, or simply some aesthetically pleasing consumer products. But as with any product WIRED loves, it will not only be about looks. Truly WIRED gear is as functional as it is charmingly crafted. It could find new ways to interpret a classic, or define an era – even an industry. Which British designer and manufacturer managed to conjure up the most wonderful objects of 2016?

Scientific breakthrough

Hard science – from chemistry to astrophysics, biotechnology and medicine – is the force that pushes forward the boundaries of what humanity can achieve. If we are to ever have superfast quantum computers, it is because of the long and hard grind of scientific experiments happening in a physics lab right now. But to deserve the label of “breakthrough”, a discovery has to solve a crucial problem while having a long-term positive impact on the future of humankind. Which scientific achievements did so in 2016?

Leadership in innovation

No innovation can exist without the trailblazers: inspiring leaders that have shown their employees, their colleagues or even the general public the way forward. The winner of this category's award will have a stunning track-record in fostering and achieving innovation in the UK throughout their entire life and career. However, the judging panel will be paying close attention to the most recent 12 months. Which individual – from an NGO, university department or private company – has been the most significant leader in innovation?



mart, connected cars might well be poised to make motor transportation more fuel and time efficient – as well as safer – but that doesn't mean the cars of tomorrow won't be exciting.

The RS 7 Sportback piloted driving concept is a 560hp five-door coupe with a top speed of 305kph (189.5mph). Audi has already showcased this luxury machine at Germany's Hockenheim circuit and the Ascari Race Resort – at race pace and without a human at the controls.

On track, this RS 7 can apply full throttle on straights, and creates up to 1.1 g of lateral acceleration when cornering. With precisely measured braking ahead of bends, it can produce g-forces of 1.3 g. Turning is smooth and follows a flawless racing line.

The car relies on GPS signals for on-track orientation, which are transmitted to the vehicle via wireless connection and high-frequency radio. 3D images are compared in real-time against graphical information stored on-board – each image is scrutinised for known features, such as buildings and trees, which the car uses as further positioning information.

#WIREDAUDI AWARDS

ARTIFICIAL INTELLIGENCE AND DRIVING

Despite its racing livery, this RS 7 is almost identical to the production model. The big difference, however, is that the power steering, brakes, throttle and eight-speed tiptronic gearbox can be managed by machine, on demand.

"Artificial intelligence can save lives, which makes it the key to greater traffic safety," says Audi CEO Rupert Stadler. "Our technology is nearly ready for series production, and with the help of policymakers we will bring highly automated driving to our roads, bit by bit."

Audi has been showcasing piloted driving since 2009, and the technology it employs is continuously evolving. Recent milestones include the zFAS hardware at the heart of the latest research models. The tablet-sized device consists of high performance processors which collate information from numerous sensors, informing the car when to turn, brake and so on.

In February, a piloted Audi A8 drove actor Daniel Brühl to the Berlinale Film Festival. In central Berlin the A8 mimicked the smooth, controlled driving of a top chauffeur. And extensive tests of "Jack", a piloted A7 Sportback, have been carried out on US highways, including a 900km drive from Silicon Valley to Las Vegas.

Such cars – which can operate independently, with human supervision – aren't yet available to the public. But the technology is making its way on to the roads. Traffic jam assist in the new A3, A4 and Q7 goes beyond adaptive cruise control by briefly taking command of steering as well as braking and acceleration in congested traffic – at speeds of up to 59.5kph (37mph). Active lane assist ensures drivers don't drift. And Audi offers several parking assistance and driver awareness tools.

The future of driving is safe, efficient and swift. **For more, see wired.co.uk/wired-audi-innovation-awards**

2009: Bonneville

Audi hits the Bonneville Salt Flats in Utah, US, to test a piloted Audi TTS at speed.



2010: Pikes Peak

The TTS conquers the legendary Pikes Peak challenge in the Colorado hills.



2012: Thunderhill

The piloted Audi laps California's Thunderhill Race Track in under two minutes 30 secs.



2014: Florida and California

Audi is the first to conduct public piloted tests on the Lee Roy Selmon Expressway.



2016: Berlin city centre

A piloted Audi A8 provides VIP transport for Daniel Brühl at Berlinale Film Festival.





Artificial intelligence is shifting from being the stuff of science fiction to firmly in the realm of science fact. But who are the innovators shaping the future of this transformative tech?

WIRED AUDI INNOVATION AWARDS

CATEGORY 1: INNOVATION IN AI

It's going to be a pivotal year for artificial intelligence (AI). And 2016 began with British AI firms asserting dominance over the sector. In February, Southwark-based predictive keyboard company SwiftKey was purchased by Microsoft for \$250 million (£173m) – one of the highest exits ever for a UK company. Around a month later, another UK-made smart machine, DeepMind's AlphaGo, trounced professional player Lee Sedol in a five-game match of Go – an ancient and complicated board game – in a historic first.

Within a few months, AI has stopped being fodder for futurists' conversations and charged headlong into the here and now. Advances in neural networks and machine learning, and the availability of vast data sets, are bringing about an AI surge that has just started gaining momentum.

This is particularly true in the UK, home to some of the most innovative and revolutionary AI companies in the world – many of which are being eyed for purchase by Silicon Valley's titans.

AI is not only good for typing faster, or for bringing world-class players to their knees. IBM's Watson can answer

complicated questions on TV quiz *Jeopardy!*, invent wild new recipes and discover profound cause and effect patterns in healthcare. London-based startup Jukedeck has devised an AI system that churns out original, royalty-free music to use in small-budget cinematic productions.

In Cambridge, VocalIQ is developing programs that can learn from humans how to speak in a natural way – and which could end up being your virtual assistant and, eventually, your friend.

THE JUDGES

Antoine Blondeau

Blondeau worked on the project that became Siri. He is CEO of Sentient Technologies.



Niven Narain

Narain is CTO of Berg, a company using AI to discover new medical drugs.



Murray Shanahan

Professor Shanahan's work in AI inspired Alex Garland's 2015 thriller *Ex Machina*.



Nathan Benaich

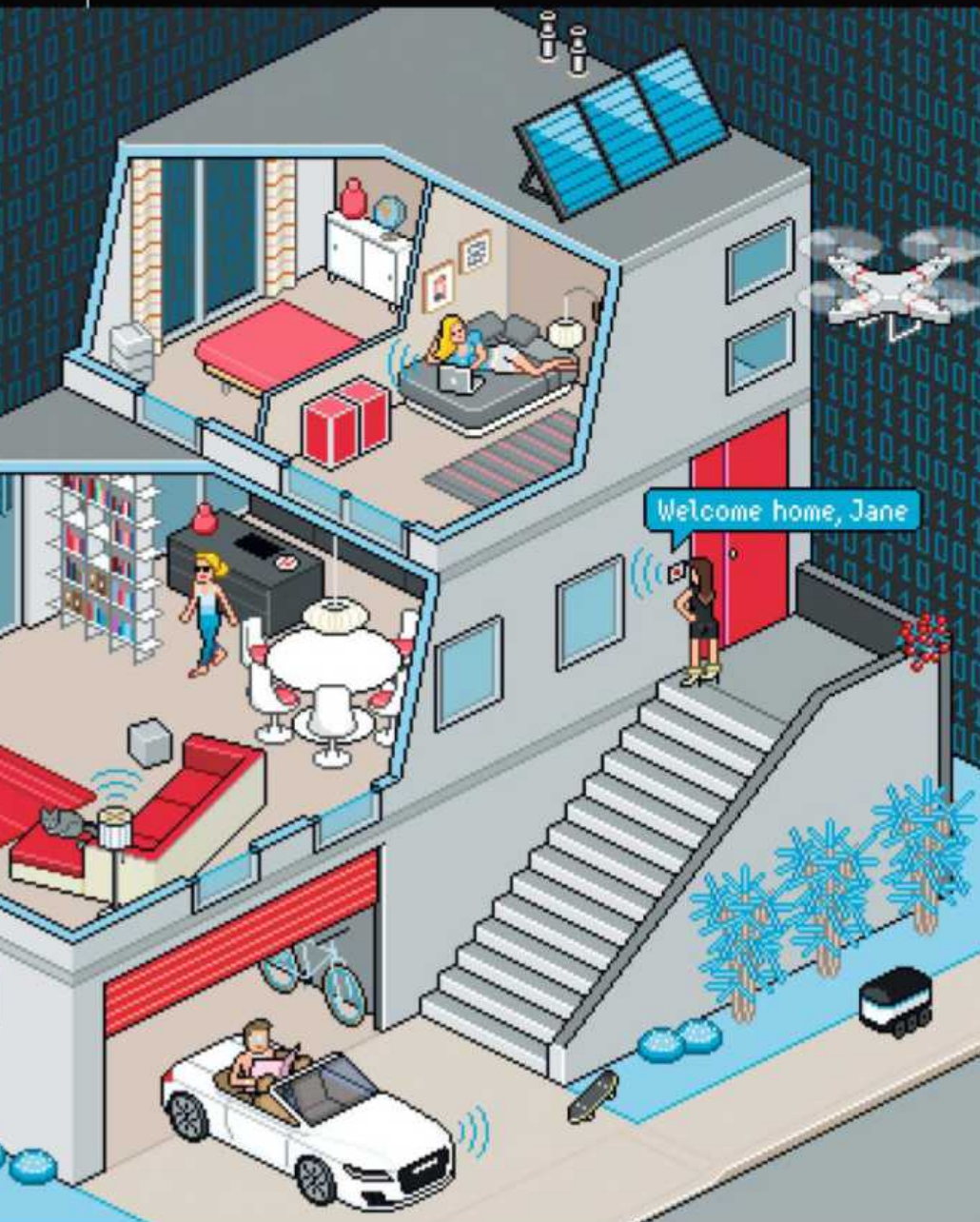
Investor Benaich is interested in pioneering big data, AI and machine learning.



Maja Pantic

At Imperial College, Pantic is studying human-machine interactions.





THE NOMINEES

Team AlphaGo
 DeepMind

Founded in 2010, DeepMind first built neural networks that learnt to play and win videogames. In March 2016 – following its acquisition by Google – its AlphaGo AI beat Go master Lee Sedol.

Chris Holmes
 Oxford University

The Bayesian statistician and professor is a leader in the field of biostatistics. He is pioneering the application of advanced machine learning to genomics and genetic epidemiology.

Ben Medlock
 Co-founder & CTO, SwiftKey

Medlock began building the touchscreen keyboard in 2008. SwiftKey is installed on over 250 million devices. Microsoft paid \$250m for the firm in February.

Mike Aldred
 Robotics category lead, Dyson

Robotist Aldred joined Dyson in 1998. An authority in machine vision, he tapped into his expertise during the decade-long design of Dyson's 360 Eye robot vacuum cleaner.

Ed Rex
 Co-founder & CEO, Jukedeck

In 2015, with a 15-strong team, Rex launched Jukedeck MAKE, an application that uses AI to generate original, royalty-free, bespoke soundtracks for enthusiasts and indie filmmakers.

Ambarish Mitra
 CEO, Blippar

When launched in 2010, Blippar was an augmented reality app, turning print ads into animated experiences. It's now developed image recognition to become a visual search engine.

Kerstin Dautenhahn
 University of Hertfordshire

Dautenhahn is a leader in the study of human-robot interaction and social robotics. Her research focuses on potential therapeutic applications for robots – from caring for the elderly to assisting autistic children.

Blaise Thomson
 Co-founder & CEO, VocalIQ

Founded in 2011, VocalIQ deploys machine learning to build virtual assistants that improve at conversing the more they interact with humans. The firm was bought by Apple – the creators of iOS assistant Siri – in 2015.

Sabine Hauert

Robotics lecturer Hauert studies swarm engineering and collective artificial systems.



According to our WIRED Audi Innovation Awards judges, the domains that could be affected by AI's advances go from "marketing, advertising and opinion polling" to "drug research and development."

More importantly, AI might save lives. Oxford researcher Chris Holmes is resorting to machine learning strategies to understand the development of genetic diseases. In May, DeepMind announced a data-sharing agreement with the NHS in a bid to use AI to spot early-stage kidney diseases.

The advent of AI has unsurprisingly been met with a mix of wariness and

fear by some experts. In January 2015, a team of techies including cosmologist Stephen Hawking and SpaceX founder Elon Musk signed an open letter urging the world to investigate the potentially disastrous consequences of creating a rogue AI.

But focusing on potential dystopian futures could make us overlook how AI can be a great force for good – something that deserves to be celebrated.

That is why we chose to launch our Innovation Awards by looking at British AI innovations and innovators. Virtual minds are here: but which one really made us think in 2016?

Next issue, categories
two and three:
Most exciting moonshot
and Innovation
in experience design
#WiredAudiAwards

WIRED Audi

INNOVATION AWARDS

Vorsprung durch Technik





The Bupa workshop, with Frog Design, took place at the Royal College of General Practitioners on the day before WIRED Health

WIRED Health returned for a third year in April. Designed to stimulate debate and spread ideas about the future of healthcare, it was the ideal environment in which to discuss wellbeing.

This is the second year Bupa has run WIRED Health workshops. The sessions are held to stimulate the “sharing of insights, co-creation and embracing person centric design thinking,” says Andrés Martín, who is responsible for Bupa’s global partnerships.

With 32 million customers in 190 countries, Bupa has a major stake in the health of populations around the world. The workshop gathered

WHAT DOES WELLBEING MEAN TO YOU?

WIRED HEALTH DELEGATES MET IN A WORKSHOP AHEAD OF THE EVENT TO EXPLORE AND DISCUSS NEW MODELS OF PERSONALISED WELLBEING

founders from the event’s Bupa Startup Stage and Main Stage, plus senior members of the Bupa team. Facilitated by design agency Frog, 18 attendees were tasked with discovering new opportunities for promoting the wellbeing of individuals and communities. Integrating their knowledge of the biological, behavioural, psychological, environmental and social contributors to wellbeing, the group set to work.

First, attendees were introduced to three fictional archetype personas from different backgrounds. Harriet is a 64-year-old retired mother living in the suburbs outside London. Asif, 47, works in a stressful IT support role in Delhi. And Maria, 20, is a student who works and plays hard, living in the Chilean capital Santiago.

Frog’s approach begins with brainstorming, with the groups defining wellbeing and listing factors that influence it. Secondly, the teams sought to identify opportunities for change in the lives of Harriet, Asif and Maria. Finally, they selected the opportunities with the highest potential.

For Maria, the prescription was the After Hours Café Club – a place for students to work, socialise and eat healthily at reasonable prices. With Asif, it was decided that employer intervention was the best remedy. The Wearables@Work scheme would give health monitoring tools to employees like Asif to help check on stress levels and promote regular exercise. Finally, Harriet would be provided with the technology, training and support to allow her to feel closer to her family who live far away and who would be able to co-monitor her health status.

“It’s an exciting way of co-creating new thinking for old problems in healthcare,” says Martín. “Innovators and thought leaders together explored new models for wellbeing engagement, aiming to help people thrive in their lives, not just fix their health issues.”

For more, see bupa.com

"In the future, 90 per cent of health-care data will be collected outside the four walls of the hospital," said Simon Nicholls, Bupa's director of global digital health, on the Bupa Startup Stage at WIRED Health. "Our focus is on how cloud computing, digital analytics and wearables can converge to allow us to collect more data than ever before."

More than step counts, this includes real medical data. BrainWaveBank – one of the 18 startups that presented – aims to reduce the cost of measuring cognitive performance by monitoring brainwave activity using low-cost electroencephalogram (EEG) headsets.

The Startup Stage wasn't only about withdrawing information from patients, but also on more efficient ways to deliver it. TalkLife can deliver certified therapist advice via Facebook Messenger, for example. ChroniSense enables chronic disease management, using real-time medical data. And the MyRecovery app helps patients recuperate from surgery.

"The WIRED Health Bupa Startup Stage is a fantastic vehicle for Bupa to connect with, and learn from, the most innovative health startups," says Andrés Martín, who oversees global partnerships at Bupa. "WIRED Health is like a one-day magic lens to see through how the future of healthcare will be."



THE BUPA STARTUP STAGE

18 COMPANIES PITCHED ON THE BUPA STARTUP STAGE. THE WINNER, SENSELY, WENT ON TO PRESENT TO THE FINAL MAIN STAGE SESSION

Dani Roig, co-founder of VR mental-health firm Psious

The strength of Sensely, the stage winner, lies in providing what digitally-delivered advice is missing. Its virtual nurses help monitor patients after discharge – giving advice, booking appointments and connecting them to human clinicians when needed.

"The avatar offers a way to bring old-fashioned bedside manners into the technology," says CEO, Ivana Schnur. It's digital and personal. bupa.com

A SELECTION OF STARTUPS ON SHOW

By analysing gut bacteria, DayTwo helps patients create personalised, informed diets.



ChroniSense wearables assist chronic disease management, using real-time medical data.



TalkLife offers a peer-to-peer support for young people battling with mental health problems.



Parkinson's treatment app *Beats Medical* provides exercises to treat the disease symptoms.



Myrecovery's app guides surgery patients through treatment and recovery, and offers symptom analysis.



Sensely provides patients with a virtual nurse to guide them through their triage process.





'AI DOCTORS WILL BECOME AS UBIQUITOUS AS STETHOSCOPES'

Kyu Rhee Chief health officer, IBM

WHAT WE LEARNED AT WIRED HEALTH 2016

**BY STEPHEN ARMSTRONG
PHOTOGRAPHY: ALEX LAKE**

On April 29, 500 health-sector investors, entrepreneurs and policy experts gathered at the Royal College of General Practitioners in central London for the third annual WIRED Health event. Twenty-one speakers took to the Main Stage and a further 18 pitched on the Bupa Startup Stage, under the curation of WIRED science editor João Medeiros. Here are a few of the significant lessons we learned.

PERSONALISED DIETS ARE THE MEDICINE OF THE FUTURE

Molly Maloof

Physician and scientific wellness practitioner



"The real question is: how do we get people addicted to the good stuff?"
– MOLLY MALOOF

Molly Maloof believes that some chronic diseases can be tackled with better food, not drugs. "We all know we should eat healthier and we have a strong desire to follow a healthy diet, but we still find ourselves eating and drinking the same foods," she said. "Why is that?"

Based in San Francisco, Maloof prescribes her clients healthy convenience food – meals from services like MediMeals or London's totaldietfood.com, ingredients from companies like Hello Fresh or The Purple Carrot, websites like Grow or Ocado which make organic grocery delivery easy, apps like *Eat This Much* and *Nutrina*, even *Instagram*. "It's filled with photos of people making incredibly healthy food and is my number-one place for finding inspiration."

At Maloof's Silicon Valley-based health optimisation practice, she's using genetics and lab testing to prepare meal programmes for her patients. "Personalised scientific diets are the medicine of the future," she explained to the audience. "There isn't one diet that fits all." But ultimately, it's not what you eat – it's what you know. "The real blockbuster drug of the century is education – getting patients to care about their health enough to do something about it."

CUSTOM-MADE CELLS CAN TACKLE LEUKAEMIA

Alejandro Madrigal *Scientific director, Anthony Nolan Research Institute*

Genetically modified stem cells could soon eliminate leukaemia tumours – by teaching immune cells to control cancer cells, Alejandro Madrigal, a surgeon and scientific director for the Anthony Nolan Research Institute, told the WIRED Health audience. "I hope that one day we will go to the drugstore to get stem cells that help us to fight cancer," he said. "We may not need transplants."

Madrigal explained that bone marrow transplantation is still the only treatment that can cure leukaemia but the survival rate for those who undergo that procedure is only around 60 per cent. "We should increase it to 90 or 100 per cent," he said.

The trust was founded in 1979 to build a bone marrow donor register by the mother of eight-year-old Anthony Nolan, who lost his fight with the disease. Since then, Madrigal told the room, the number of people on bone marrow donor registries has reached 28 million.

The process still requires donors, but Madrigal says that, if he can take cells from healthy people and tweak them in a lab, he hopes to be able to design custom-made donor cells, equipped for each individual leukaemia patient, to both attack cancer cells and tackle the inflammation and graft-to-host disease that can cause transplants to fail.

Madrigal has led this international immunotherapy research project since 2014 and it will soon enter the testing phase. "We are living in an exciting time," he said.



"One million patients who would have died have been given a chance of life"
– ALEJANDRO MADRIGAL

MENTAL ILLNESS NEEDS TO BE HEARD

Jen Hyatt

Founder, Big White Wall

Jen Hyatt, a mental health advocate, told the room that 75 per cent of people with mental health issues receive no treatment – and half of those with a diagnosable problem don't even consult a primary care doctor.

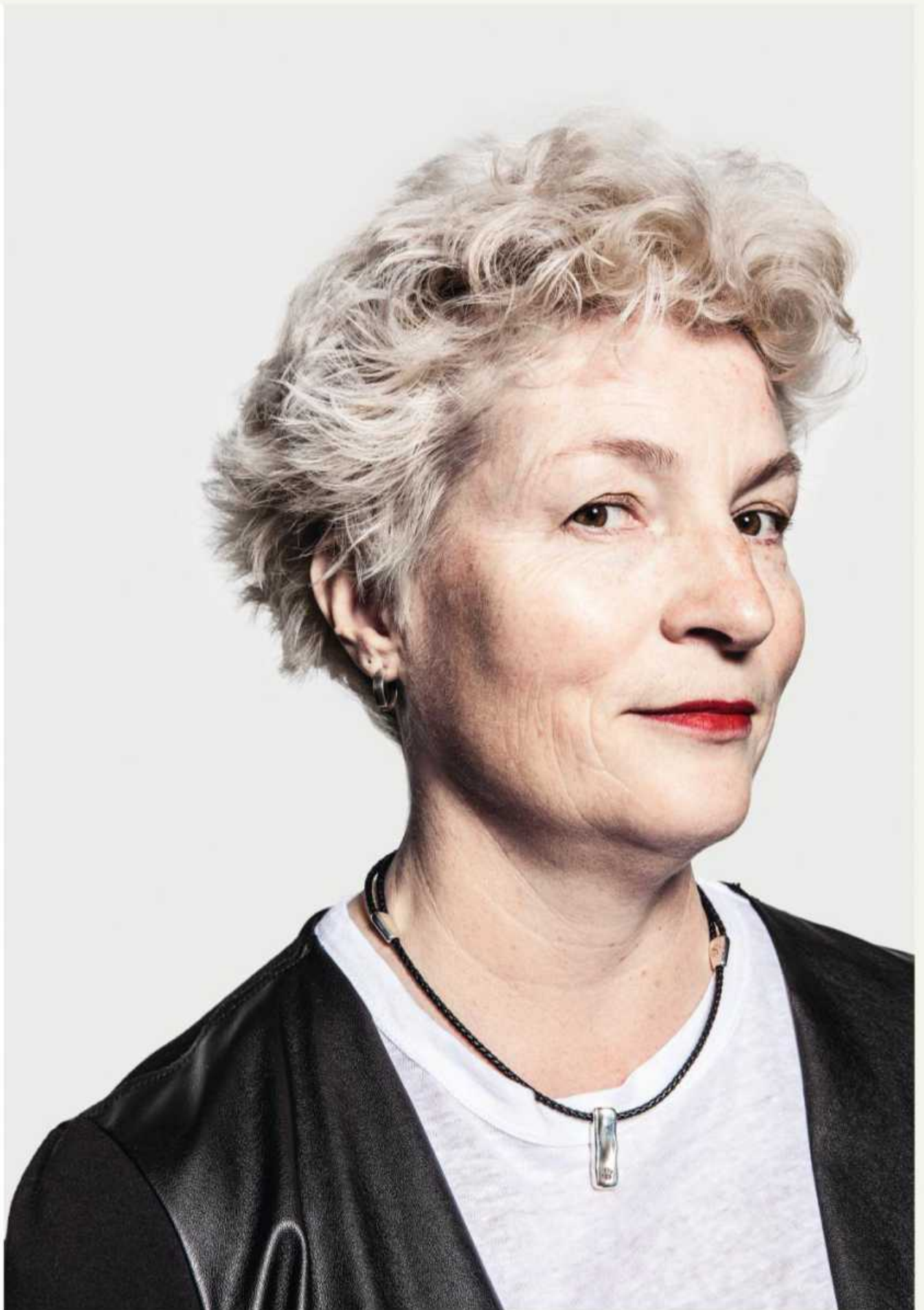
"Instead of focusing on illness," she said, "we could focus on healthy behaviours and better self-care."

In 2007, Hyatt founded Big White Wall, a digital service available online and via an app. It helps people with depression and anxiety manage their own mental health. Supported by the NHS, it is staffed round the clock by experts. Members can post images, drawings and words to "The Wall", talk anonymously to other members or join a guided support course and take one-to-one online therapy via a webcam, audio or instant messaging.

"There is no universal panacea," Hyatt said. "The community wanted choice – to be able to choose the therapies they work with, not be given one." Underpinning it all, she added, were evidence based treatments. "A small percentage of digital interventions pay attention to evidence."

Listening to members means learning and changing: "Eighty per cent of people that came to us said that their primary reason was isolation," she explained. "So we introduced this place called Accompaniment that meant you are never alone except by choice."

And Hyatt's next challenge? "There is this prevalent understanding that says one in four people experience poor mental health during their lifetime," she said. "Who would dare say that one in four people experience poor physical health during their lifetime? You can have everything from the common cold through to enduring mental health issues. It's all interconnected."



"Let's not move deckchairs around on the *Titanic* – let's address the big numbers" – JEN HYATT



ON THE STAGE AT WIRED HEALTH

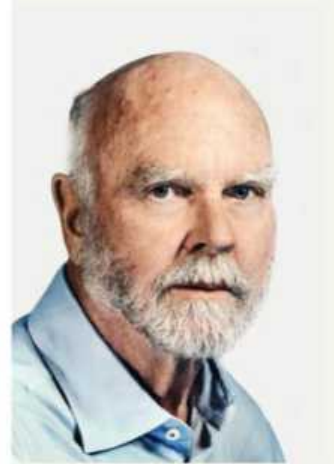


FROM BEIJING TO BOSTON



Top row, left-right:
Alejandro Madrigal, scientific director, Anthony Nolan Research Institute;
Andrew Dawood, specialist in periodontics and prosthodontics, Dawood & Tanner;
Jeremy Farrar, director, Wellcome Trust;
Kyu Rhee, chief health officer, IBM; **Gero Miesenböck**, professor of physiology, University of Oxford ♦
Second row, left-right:
Geraldine Hamilton, president and chief scientific officer, Emulate;
Jen Hyatt, founder, Big White Wall;
Shafi Ahmed, co-founder, Medical Realities;
Jo Mountford, head of tissue and cellular therapeutics, Scottish National Blood Transfusion Service;

Craig Venter, co-founder and CEO, Human Longevity ♦
Third row left-right: **Josh Stephenson**, designer;
Jim O'Neill, commercial secretary to the Treasury;
Vincent Walsh, professor of human brain research, UCL;
Tim Spector, professor of genetic epidemiology, Kings College London;
Anna Young, co-founder, MakerHealth ♦
Bottom row, left-right:
John Donoghue, director, Wyss Center;
Molly Maloof, physician and scientific wellness practitioner;
Ye Yin, CEO, BGI Genomics;
Lucy McRae, science fiction artist and body architect;
Mahiben Maruthappu, co-founder, NHS Innovation Accelerator
José Gómez-Márquez, director, Little Devices @MIT





"More than 50 per cent of antibiotics prescribed in the US are not needed" – JIM O'NEILL

STARTUP FUNDING CAN FIGHT BACTERIA

Jim O'Neill *Commercial secretary to the Treasury*

Drug-resistant bacteria are killing 700,000 people around the world every year. If we don't do something within 35 years that number will rise to ten million, outstripping cancer as our most deadly foe, according to Jim O'Neill, the economist charged with leading the government strategy on superbugs.

But O'Neill has a plan. And as you'd expect from a former chief economist at Goldman Sachs, it involves some big numbers: "The economic cost of not doing anything is about \$100 trillion [£69tn]," he said. "We could lose more than we'd gain if we doubled the world economy over the next ten years but didn't tackle antimicrobial resistance."

O'Neill's ten-point plan is simple: begin a global public awareness campaign supported by the dynamic involvement of startups and a focus on basic sanitation, particularly in the developing world. Farming, for one, must help: "We need to introduce much better behaviour in agriculture: 70 per cent of all antibiotics in the US are in agriculture, not humans."

He called for global surveillance, and suggested vaccines could play a role as a substitute for antibiotics.

Then there is the supply side. O'Neill called for more and better-paid researchers ("fewer people work in this than in other areas, and those that do are paid less"); incentives for incumbent drug companies and startups to produce new drugs; state of the art diagnostics – what he calls "Google for doctors"; and the need to "get this agreed around the world and have a G20 agreement".

The cost for these suggestions? He estimated \$30 billion or one quarter of one per cent of global GDP over the next decade – less than the top three US big pharma companies spent on buying back their own shares this decade. If we fail, he warned, caesarean births, cancer treatments or even relatively minor conditions like a graze on the knee might risk untreatable bacterial infection: "You might not be able to get treatment that can deal with that because we don't have the antibiotics..."

"[With VR] the world becomes a simpler place to teach people"
– SHAFI AHMED



VIRTUAL-REALITY TRAINING WILL SLASH WAITING LISTS

Shafi Ahmed *Co-founder, Medical Realities*

A simple £4 Google Cardboard device could save 17 million lives by helping train more than two million extra surgeons around the world, virtual-reality surgeon Ahmed told the WIRED Health auditorium.

Ahmed explained the results of his latest experiment: Virtual Reality in the Operating Theatre. In April 2016, he live-streamed, using Google Glass, a colon-cancer operation he performed on a patient. It went out to 4.6 million viewers in 142 countries. "We created a free app on the App Store and Google Play," he explained. "Then we uploaded the whole operation so you can watch live or in VR – three clicks and you're in."

Ahmed said he was inspired by the Lancet Commission's "Global Health" report last year that claimed five billion people have no access to safe and affordable surgery. "To make that more equitable, we need to produce 143 million extra operations a year," he explained. "So what are the solutions? My vision is the virtual surgeon."

Trainees can put on a headset, with a simulated body in front of them, and using haptic technologies pick up and feel a blade then experience the sensation of cutting in. "This virtual simulation will be the best immersion we can achieve," Ahmed said.

He went on to argue that this training allows pockets of excellence in the NHS to become a national standard. "We now have an NHS chief executive supporting innovation so I'm optimistic we can achieve that within the next two to three years," he explained.

And the long-term future? "The singularity – the point at which a robot surgeon is better than a human – is going to happen, but it's some way off. The virtual surgeon can spread worldwide today."

BRAIN STIMULATION WON'T KILL STUDY

Vincent Walsh *Professor of human brain research, UCL*

In the future, we all might be tweaking our brains with electric impulses to treat depression, do better at school and work, perform better at sports, sleep sounder, even improve our orgasms, said Vincent Walsh, one of the world's leading researchers into neuro-stimulation.

Walsh told the room that his own early research with transcranial direct-current stimulation (TDCS) provided evidence that it could help concentration and athletic performance, but his 2010 paper on this topic had results that no-one has managed to repeat since. He now suggests that targeting the brain's plasticity with more traditional methods shouldn't be overlooked in the rush to embrace technology. (He offered full disclosure that he's an adviser for brain-training app *Peak*.)

"We seem to be becoming obsessed with technological ways of learning and trying to short-circuit learning," he explained. "We are carrying around with us the tools for learning. We already understand the science of memory – we know how to learn and motivate people. If you want to learn something you have to make an effort and you have to make that effort repeatedly. It's not a brain-stimulation problem, it's a behavioural problem."



"I steer away any athlete who even dreams of using brain stimulation"
– VINCENT WALSH

AI WILL MAKE DOCTORS' APPOINTMENTS MORE MEANINGFUL FOR ALL

Kyu Rhee *Chief health officer, IBM*

In the near future, patients will be treated by AI doctors that can access the latest research, analyse medical records, textbooks and journals and monitor similar cases all in 17 seconds, according to IBM's Kyu Rhee.

A former doctor, Rhee gave the conference an insight into the realms of paper-based charts that were his typical diagnostic aids. "It's humanly impossible for me to know everything that's in every one of those charts," Rhee said. "I had maybe 2,000 patients. To know everything about every person was very challenging. I would typically get 15 minutes with each patient to listen, learn, address and support issues from diabetes, arthritis and asthma to heart disease."

IBM's Watson computer – made famous when it won the US gameshow *Jeopardy!* in 2010 – is a cognitive system that understands, reasons and learns, allowing patient information to overlap with existing trends and tap into local knowledge and global expertise.

An AI doctor shouldn't replace a human physician, Rhee said, but complement one. "The skills that humans have – the compassion, the ability to abstract, to generalise, to have common sense, to have morals – are all key aspects of healthcare. Technology should be used to improve these relationships, not make them harder."

AI systems aren't just about diagnosis, he argued. "Developed countries have gained 30 years of life expectancy in 100 years," he explains. "But only three of those 30 are related to healthcare innovations. Things like traffic safety, water safety and food safety play a role."

Combining wearables, AI, big data and social-care records could prove the next big intervention, he said. Wearables could log activity and share it with a doctor, alerting them when there are changes that could affect physical or mental health – from blood sugar to sleep patterns.

"If [a patient] has hypertension and comes to see me once every three months, I have 15 minutes for medicines, his diary of blood sugars and his blood pressure," Rhee explained. "Out in the community he's dealing with all the other determinants of health from food to crime to unemployment... even the weather. Putting all that data together means we could be pro-active, predictive and personal."

"Each of us will produce 300 million books' worth of data in our lifetimes"
– KYU RHEE



THE WIRED HEALTH CLINIC EXHIBITORS

Cavendish Imaging
Chronisense Medical
Dawood & Tanner
Digits2Widgets
Formlabs
Galvanic
GiveVision
Holoxica
Klarismo
Little Devices
Lucy McRae Medical
Realities
Parasym Health
Peak
Pop-up Labs
Psious
Qardio
Random42
Withings
Under Armour



PLUS: PITCHING FROM THE BUPA STARTUP STAGE

Entrepreneurs from as far as California and Israel shared their visions to a panel of judges at WIRED Health. Covering issues from brain training to microbiomes to nursing, here are 2016's innovators

Ciara Clancy Beats Medical
Ronan Cunningham BrainWaveBank
Danny Lange ChroniSense Medical
Vedrana Höggqvist-Tabor Clue
Ben Fehnert Ctrl Group
Lihi Segal DayTwo
Maria Pereira Gecko Biomedical
Marek Sacha Golden Era Club
Mark Matthews HealthRhythms

José Antonio Bastos Knok Healthcare
Tom Harte MyRecovery
Nora Khaldi Nuritas
Laura Indolfi PanTher Therapeutics
Dani Riog Psious
Anne Bruinvels Px HealthCare
Ivana Schnur Sensely (winner, pictured)
Jamie Druitt TalkLife
Cristian Pascual Teckel Medical

WATCH WIRED HEALTH ONLINE

You can see and hear all the speakers from the Main Stage at wired.co.uk/wired-health-2016



Health has always been a personal matter – now, technology is making it personalised. At WIRED Health 2016, Craig Venter explained how genome sequencing can help spot illnesses and deliver ultra-tailored treatments; and other speakers discussed designer diets and specialised prosthetics.

This trend is no surprise to AXA PPP healthcare – event partner and founder of the AXA PPP Health Tech & You initiative – which is adapting to the way in which consumers increasingly want to access health information to take better care of their wellbeing.

AXA PPP HEALTH TECH & YOU

THE WIRED HEALTH PARTNER HAS BEEN
REWARDING THE COMPANIES PIONEERING
INNOVATION IN HEALTHCARE TECHNOLOGIES

“Traditionally there’s been a one-size-fits-all approach in the medical arena, but technology is democratising that,” says Gordon Henderson, director of Digital & Innovation, AXA PPP healthcare. “Now an individual can find their personal needs met through technology – very specifically met. This is giving people the capability to really take care of their health.”

Central to the initiative is the AXA PPP Health Tech & You Awards. Now in its second year, it received over 200 entries, explains Henderson. “What really impressed us this year was the niche aspect of many of the entries. There wasn’t some big cure-all for any kind of problem, but rather there were several very specific products that met very specific needs.”

Among the recently announced winners showcased at WIRED Health were a bespoke app for people with food allergies, a light-based walking aid for Parkinson’s patients and a Bluetooth colostomy bag sensor. AXA PPP Health Tech & You, and its partners the Design Museum and 2020health, are already on the lookout for entries for 2017. **Download the app via Google Play and App Store; see healthtechandyou.com**

AXA PPP HEALTH TECH & YOU WINNERS 2016

Innovator Award: Helen Hamlyn, Royal College of Art
Champion Award: Patients Know Best – a doctor-patient info-sharing tool
Breakout Award: Ostom-i, the smart colostomy bag
Problem/Solution Award: Pysomics, a biotech firm taking on psychiatric work.

The Health and Care award went to FoodMaestro, an app that helps users source diet-specific foods.



Laser light-based walking aid Path Finder, by Walk With Path, picked up the Independent Living Award.



SlowMo won the One To Watch award. The mobile app is an aid for people battling paranoia.



life's good
when you
play more

LG G5 & LG Friends

With a collective of LG Friends, these companion devices connect with the LG G5 to bring ultimate expandability.

Find out more at: lg.com/uk/lg-friends

android 





Your recordings,
anywhere around your house

This is Fluid Viewing™



Includes TV recordings from your Sky Q channel pack and most free to air channels. See www.sky.com/SkyQchannels for info. Requires Sky Q box, subscription, app and compatible tablet (www.sky.com/SkyQdevices) or Sky Q Mini connected to home broadband. Recordings tab shows recordings plus on demand downloads. BBC on demand content unavailable via Sky Q app. 24 © 2001-2010, 2014 Fox and its related entities. All Rights Reserved. Series 1 - 9. Cinderella © 2014 Disney Enterprises, Inc. The Flash and all related characters and elements are trademarks of and © 2016 DC Comics. © 2016 Warner Bros. Entertainment Inc. All rights reserved. Mad Max Fury Road © 2016 Warner Bros. Entertainment Inc. All Rights Reserved.

Recordings

The Flash
Dazzling US superhero
Meet Barry Allen, a CSI investigator
suddenly develops a need for speed.

Most recent



Cinderella

The Flash



Mad Max Fury Road




24

Monday 7.11pm



sky





live the WIRED life

Every year, WIRED staff submit their personal picks of essential items. From screens to scoops, wheels to waterproofs, here is our guide to this summer's 106 must-have objects of desire

**Edited and compiled
by WIRED product
editor Jeremy White**

**Photography:
Baker & Evans**

2



1. NITRO ICE CREAM

London's Chin Chin Labs serves the best ice cream in the UK. The flavours, such as burnt butter caramel and blueberry gin, lure us, but the fact that each ice cream is made to order using liquid nitrogen has the competition licked. chinchinlabs.com

5. PRIMO CUBETTO

A screen-free coding toy for children aged three plus, Primo's Cubetto has physical building blocks that can be put together like a jigsaw to help to teach Cubetto, a cute wooden robot, how to move from A to B. \$225 primotoys.com

8. PRETTY MUCH EVERYTHING

This book surveys the work of Aaron James Draplin and his Draplin Design Co. Striking logos, campaigns and record covers are mixed with pithy advice and commentary on the 21st-century design scene. \$40 draplin.com

2. PANASONIC 4K PRO VIERA DX802

The DX802 has a polished aluminium frame and fabric-covered 12-speaker soundbar that blends unobtrusively into a living room. The 4K UHD LED screen offers outstanding contrast. etbc.panasonic.com

6. NERI PENCIL

This innovative piece of stationery has a rotating brass screw which allows writers to regulate lead and nib length with a simple turn – a technique borrowed from compasses used in architectural drawing. £33 internoitaliano.com

9. TRACKSMITH SINGLET

Tracksmith makes design-led running kit that looks the part whether you're pounding pavements or going into town. Colours are understated more than garish, but with plenty of technical know-how. *Tops from \$55* tracksmith.com

3. NIXON MISSION

With an impressive 10ATM rating, this is the world's first action-sports smartwatch powered by Android Wear. It's particularly useful for surfers and snowboarders, as it comes with apps that deliver real-time wave and snow reports. etbc.nixon.com

4. STUTTERHEIM STOCKHOLM RAINCOAT

Featuring rubberised cotton with double-welded seams, silver buttons and hemp strings, the Stockholm is based on founder Alexander Stutterheim's grandfather's old raincoat. *From £130* stutterheim.com

7. MICROPLANE HERB MILL 2IN1

As well as a rotating blade for cutting mint, coriander and parsley very finely, the Herb Mill also has a stripping mechanism for removing rosemary and thyme from tough stems and stalks. £22 microplane-brandshop.com

10. LAND ROVER DEFENDER PEDAL CAR

Land Rover's scale model of its off-road icon is the most faithfully constructed toy car WIRED has seen, right down to the mud flaps, running bars, spring suspension and a full braking system. £10,000 landrover.com



1



2

Tour de France riders climb Col du Tourmalet on the cover of *Mountains: Epic Cycling Climbs* by Michael Blann (Thames & Hudson). Out September 2016



3



4



5



6



7

The interior of the small-scale Defender has leather-finished seats and steering wheel




8



9



10



The 200mm-tall Indefinite Vase 01 is formed using Portoro marble and transparent glass

Give your
fireplace
some
gravity

11. INDEFINITE VASES

This collection of receptacles from Stockholm-based agency Studio E.O aims to juxtapose geometric and organic forms. Still-pliable hand-blown glass vessels are married with cut marble, granite or onyx, then gravity determines the final shape. The designers say it creates "interplay between a fragile material and its solid counterpart". WIRED says they look rather nice. From €550 studioeo.se

12. JAGUAR F-PACE

Based on the modular aluminium platform used for the XE and XF, this is the first SUV in Jaguar's 70-year history. The car comes in at just 298kg, meaning its economy is superb in its class at 24.5kpl combined fuel economy. What's more, the F-PACE can hit 0-100kph in 8.5 seconds and reach a top speed of 209kph. The SUV has a number of new technologies, including an improved touchscreen InControl Touch Pro entertainment system. WIRED's favourite part, however, is the waterproof Activity Key: an RFID wristband that can be used to lock and unlock the vehicle should you wish to leave the keys in the car. From £34,170 jaguar.co.uk

Jaguar's
modern
spin on
the SUV



The waterproof Activity Key deactivates the car's key when it's in use, rendering it useless to thieves

13. VIFA OSLO SPEAKER

Portable speakers don't come more attractive than this. Finished in Kvadrat wool and available in five colours, it features two 50mm Vifa units with aluminium cones and two 65mm flat sandwich cones to produce a deep, rich sound. *€499 vifa.dk*

15. KITCHEN BY THOMAS KITCHEN ASSISTANTS

Made from wood and silicone, these non-stick utensils are a cut above wooden servers. Choose from spaghetti server, basting brush, spoon, turner and ladle - all scratch- and heat-resistant. *From €10 rosenthal.de*

14. HP ENVY CURVED ALL-IN-ONE

The ENVY's 34-inch curved screen places you in the middle of the action. Its NVIDIA GeForce 960A card delivers sharp graphics and the six speakers are tuned by Bang & Olufsen. *£2,000 store.hp.com*

16. KNOG OI BIKE BELL

The traditional bell has typically been an obvious flaw in a bike's sleek design. The Oi abandons the bulbous shape for a simple band that wraps round the handlebars and produces a precisely pitched multi-tonal ring. *\$31 AUD euro.knog.com.au*

13



14



15



16



The Kitchen by Thomas utensils can handle temperatures up to 220°C, and also come in grey

17. SABI SPACE

This award-winning range of bathroom storage products comes from creative consultancy MAP Project Office. It's simple to install - just attach using wall mounts that are fixed with high-strength, moisture-resistant tape. *From \$20 sabi.com*

21. ALICE MADE THIS THOMAS CUFFLINKS

Available in rhodium or gold, these reflective, UK-made cufflinks have a brass base which is electroplated using nanotechnology methods, a technique usually reserved for electronics. *£140 alicemadethis.com*

17



18. NIKELAB AIR MAX 1 ROYAL

A classic style remodelled with luxury materials, the Royal has a Phylon midsole to house Nike's signature Max Air unit. A synthetic suede upper and leather heel wrap completes the iconic design. *£190 nike.com*

18



19. OLD SPIKE COFFEE

This south London operation roasts sublime single-origin beans for mail-order subscribers. It also doubles as a social enterprise, employing homeless people to work in its roastery and shop. *£7.50 for 225g oldspikeroastery.com*

19



20. STELTON THEO COFFEE MAKER

With three small holes for your brew to drip through, this filter slows things right down. The pot comes with a silicone heat seal and a bamboo lid to keep two cups' worth of coffee warm. *449 DKK steltonshop.dk*

20



21



22



Best for
mixing
retro
with eco

22. KNOMO OXBERRY

Offering the protection of a briefcase with the flexibility of an unstructured bag, the Oxberry comes with a shockproof laptop sleeve. It is constructed from recycled bottles finely woven into a stylish, canvas-like textile. *£129 knomobags.com*

23



24

**23. ACTEV ARROW SMART-KART**

This electric kart has a top speed of 19kph and customisable bodywork, but its real selling point is its parent-friendly app, with speed control, geo-fencing and emergency stop button. *\$499 actevmotors.com*

24. TALA LED LIGHTS

Thin LED strips enclosed in a traditional blown-glass envelope create the look and feel of a traditional Edison-style bulb with more than 100 lumens of warm light, while delivering over 90 per cent more energy efficiency. *From £13 taled.com*

25



The LG Signature OLED 4K Smart TV comes with voice recognition and two pairs of 3D glasses

25. LG SIGNATURE OLED 4K SMART TV

Each of the 8.3m pixels on this OLED screen can be switched off individually to produce deep blacks and provide powerful contrast. A diode film is applied directly to the glass sheet for an ultra-thin profile. *bbc lg.com*

26



27

**26. KUBERG FREERIDER**

This "clean" dirt bike is powered by a 22Ah lithium polymer battery and has a top speed of 55kph. There's also an optional dongle to sync sensor information on battery level, speeds and torque to your smartphone. *£3,500 e-scape.org.uk*

27. ZEMI ARIA

Designed by WIRED favourites Francesco Pellisari and Ron Arad, this Apple AirPlay and Bluetooth speaker looks as stunning as it sounds. Key features include three 125W amps, a carbon composite woofer and two silk dome tweeters. *£500 zemiar.com*

APPS WIRED LOVES**THE NOISE**

Suffering from bothersome builders or noisy neighbours? *The Noise App* makes it quick and easy to record auditory disturbance and report it. *iOS, Android, free thenoiseapp.com*

**PAUSE BY USTWO**

PAUSE invokes your body's in-built rest-and-digest response. Interact with an on-screen circle and improve concentration and relaxation. *iOS, Android, £1.50 ustwo.com*

**CAPO TOUCH**

Teach yourself to play the music on your iTunes playlist. It identifies chords when you open a song; you play along at your own pace. *iOS, £7.99 supermegaultragroovy.com*

**SKILYNX**

SkiLynx logs your activity to build a record across seasons and resorts. You can also arrange meet-ups using location-aware messaging. *iOS, £2.29 skilynx.com*

**VIVINO**

Outsmart the sommelier by scanning wine-bottle labels to match them against ratings from a community of oenophiles. *iOS, Android, Windows, free vivino.com*

**BLACKBOX**

This will expand your mind as well as entertain. Play games by tilting or talking to your device – no screen-touching required. *iOS, free blackboxpuzzles.com*

**ONETAB**

This extension converts tabs into a list of URLs, saving memory and speeding up your computer. They're also shareable. *Firefox, Chrome, free one-tab.com*

**BBC MUSIC APP**

BBC Music lets you search for tracks you've heard on the Corporation's stations and create playlists you can upload to streaming services. *iOS, Android, free bbc.co.uk*

**X.AI**

X.ai's "Amy" does the laborious work of setting up meetings for you. Sign up for the virtual assistant, copy her into emails and she'll do all the rest. *Free beta x.ai*

28. MONT-REBEI GORGE

If you want a break from all things WIRED, Mont-rebei Gorge has been uncrossed by road, railway or electricity line. Widely considered to be one of northern Spain's best hikes, the walls of the 500-metre-deep gorge, now a wildlife refuge, are at points close to within 20 metres of each other. The trail is an old bridle path carved halfway up the vertical wall – a head for heights is recommended. montrebei.net/en



29

Best for
minimalist
audiophiles



**ALBUMS
GUARANTEED TO
GET THE
MOST OUT OF
YOUR SPEAKER:**

Mark Pritchard
Under The Sun
(Warp)

Let's Eat Grandma
I, Gemini
(Transgressive)

ANONHI
Hopelessness
(Rough Trade)

White Lung
Paradise
(Domino)

Prins Thomas
Principe Del
Norte (Smalltown
Supersound)

29. HULT PAVILION

Swapping the conventions of speaker design for the inspiration of architect Frank Lloyd Wright, the Bluetooth-connected Pavilion rests on a high-density concrete base that provides a solid vibration dampener. Inside, an attractive copper spiral boosts lower frequencies from a 20W full-range Tymphany Peerless transducer to produce clean and warm bass sound. \$389 hultdesign.com



30



31



32



33



34



35



36



37



38



39



40

30. ICE FULL FAT 26FS

This UK-made off-road trike is an updated version of the model that journeyed across the Antarctica to the South Pole in 2013. It has a heat-treated 4130 chromoly frame, a Rohloff XL 14-speed gear hub and Tektro hydraulic disc brakes. £4,232 icetrikes.co

The Beecaster has four sound pickup options: mono, stereo and wide or focused stereo

31. SAVER EMERGENCY BREATH SYSTEM

Smoke alarms are essential, but it's what you do once they go off that could save your life. The Saver Emergency Breath System filters out smoke, carbon monoxide and other toxic gases, and dust. From \$69 mysafetyiq.com

32. PI LAB: EDWIN

No mere rubber duck, Edwin is packed with tech, from accelerometers to touch sensors and Bluetooth. He's a games controller, a night light and, thanks to an integrated thermometer, can monitor bath water temperature. \$99 edwintheduck.com

33. iPad Pro

The superb 12.9-inch model boasts Apple's most vivid Retina display to date and the highest resolution of any iOS device. Its 9.7-inch sibling has a 12MP iSight camera, and can record 4K video and up to 63MP panoramas. From £499 apple.com/uk

34. ALLBIRDS WOOL RUNNERS

Made from New Zealand merino wool, Allbirds' shoes wick away sweat, keep your feet warm in winter and cool in summer, and are soft enough to wear sock-free. They're even machine washable. \$95 allbirds.com

35. BEATBUDDY PEDAL

This micro drum-machine is a pedal pre-loaded with more than 200 patterns across 21 genres. Featuring live drum recordings, rather than synthetic beats, adds a realistic edge. And it's all controlled at the tap of a foot. \$299 mybeatbuddy.com

36. OXX COFFEEBOX

You want proper coffee outdoors? You got it. This rugged and rust-resistant brewer pumps out cups of coffee in three different sizes from K-Cup coffee packs in less than 90 seconds drawing on its 2.5-litre water tank. \$250 oxx.com

37. DENON HEOS 1

Perfect for small to medium rooms – including steamy bathrooms – this Wi-Fi speaker can play hi-res audio and be stereo paired. The Go Pack adds portability with a twist-on battery and Bluetooth. £199 (speaker); £79 (Go Pack) denon.co.uk

38. BEECASTER PODCAST MIC

Leaving aside its natty yellow-and-black finish, the Beecaster is the perfect podcast mic for budding audio fanatics. It has four sound pickup patterns and the ability to produce high-res audio. €200 neatmic.com

39. THINGMAKER 3D PRINTER

A toy that makes more toys? Has the world gone mad? Using templates on its app, this 3D printer can turn out goodies from jewellery to dinosaurs – and you can also design your own playthings. \$299 thingmaker.com

40. SATECHI TYPE-C USB HUB

Still struggling with your new MacBook's sole USB-C port? This neat 45g hub expands your options to USB 3.0 and Micro and Micro SD card. It even comes in silver, gold or space grey, to complete the camouflage. \$35 satechi.net

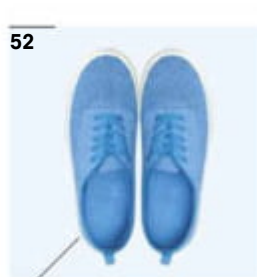
2,526-piece,
eight-hour
Bat-build!

The Batcopter has two missiles (you'll have to make your own shark-repellent Bat-spray...)



41. LEGO BATMAN CLASSIC TV SERIES BATCAVE

Holy construction kits, Batman! This LEGO set harks back to the camp heyday of the 60s *Batman* TV series, and includes Bruce Wayne and Batman, Dick Grayson and Robin, Catwoman, the Joker, Alfred, the Riddler and the Penguin mini-figs. Slide down the hidden Batpoles in Wayne Manor's library and fight injustice with the show-accurate Batmobile, Batcopter and Batcycle. £230 shop.lego.com



42. KINDLE OASIS

The newest Kindle's odd wedge shape is, in fact, a genius idea – shifting the device's centre of gravity to one side makes the Oasis a pleasure to hold for long reading sessions. And yes, it automatically flips for lefties. £270 amazon.co.uk

46. BANG & OLUFSEN BEOPLAY A6

This thin and adaptable A6 speaker produces spacious sound in any position, from wall to floor. A technical wool-blend fabric cover, created by Kvadrat, provides perfect acoustic transparency. £799 beoplay.com

50. ÜLLO WINE PURIFIER

Made from hand-blown borosilicate glass, this funnel sits neatly atop your wine glass or carafe, where its food-grade polymer filter will remove sulphites and sediment as you pour out your favourite vintage. From \$60 ullowine.com

43. APPLE WATCH IN SPACE BLACK

Cold-forged from corrosion-resistant 316L stainless steel, its black diamond-like carbon coating is polished to a mirror finish – perfect paired with a bright strap. Oh, and it's also a pretty good smartwatch... From £479 apple.com

47. MERAKI ROOM SPRAYS

Available in sandalwood and jasmine, fig, and white tea and ginger, Meraki's natural room sprays leave spaces crisp and clean, without the lingering synthetic whiff of some lesser air fresheners. £13.50 merakishop.dk

51. LIGHT L16 CAMERA

As slim as a smartphone, but with the ability to take stunning DSLR-quality photos, this portable camera captures shots of up to 52MP. Easy touchscreen navigation, built-in Wi-Fi and on-board editing tools seal the deal. £tbc light.co/camera

44. ZTE SPRO PLUS

Swapping LEDs for superior lasers, this Android-based touchscreen-controlled projector delivers an 80-inch, 1,280 x 720 HD image from just 2.4 metres away. A 500-lumen brightness rating makes for a clear and sharp image. £tbc ztedevice.com

48. RICOH WG-M2

This adventure-ready camera is waterproof to 20 metres, shockproof to a two-metre drop and cold-proof to -10°C. A wide-angle lens captures up to 204° of 4K video; pick Narrow mode to shoot at a more natural 151° perspective. \$299 us.ricoh-imaging.com

52. PEOPLE FOOTWEAR STANLEY KNIT

Hawaiian Blue, pictured here, is just one of a spectrum of bold colours from Vancouver-based People Footwear. The Stanley has computer-knitted uppers and a comfy rubberised foam EVA outsole. \$89 peoplefootwear.com

45. PHILIPS FIDELIO B5

This ingenious soundbar has two detachable wireless speakers – break them away from the main bar to create an effortless surround sound system. These moveable marvels can also act as portable Bluetooth speakers. £600 philips.co.uk

49. LONE STAR EDITION STAND UP PADDLE BOARD

Finished in cedar, cherry and fir wood over a recycled-foam core, this Texas-inspired 13.6kg stand up paddle board is ideal for speeding along on calm-water stretches. \$2,300 fourstjames.com

53. PIONEER XDP-100R

Unwilling to compromise audio quality for portability? The XDP-100R can play hi-res, WAV and FLAC files at 384 kHz/24-bit resolution, and DSD files at up to 11.2 MHz, or stream losslessly from Tidal and Apple Music. £499 pioneer-audiovisual.eu

54. INFENTO KIT

Build a range of constructible rides that will see your child through from toddler to teenager. Sidestep the LEGO and Meccano, and teach them how to create a walker, scooter, tricycle, bicycle, go-kart, skiboat and more. From €349 infentorides.com

58. MIDORI PENCIL

Japanese stationary brand Midori's latest pencil is made from cedar wood, aluminium and turned brass (the finish oxidises over time). Bullet-shaped when closed, its two-part design opens to create a full-length drawing tool. £15 theshopkeeperstore.com

62. HEAD ISUPERSHAPE

Designed for versatility, these skis are wide enough at the tip to mow through powder, but its thin waist offers rip-sharp turns on hardpacked snow. KERS technology stiffens the tail as you exit each turn to keep edges locked down. £409 head.com

55. LOOP DISPLAY

This connected digital photo frame can tune in to an event, hashtag or friendship group-specific photo channels from Dropbox, Facebook and Instagram. Browse through a photo stream and Favourite, Like or bookmark the current post. \$199 joinloop.com

59. BMW 740LD XDRIVE

The xDrive edition of BMW's 7 Series – available in the UK for the first time – means this long-wheelbase executive runabout can also handle off-road action. If you can bear to see the mud splashes, it's a smooth ride for rough terrain. £76,010 bmw.co.uk

63. AKG N60 NC

Take control of your personal soundscape – the N60 NC's active noise-cancelling clears out background conversations for total audio immersion. Bask in reference-quality acoustic reproduction for 30 hours per charge. £230 uk.akg.com

56. GROW GREENHOUSE

Ideal for nursing plants in small spaces, Caroline Wetherling's clever little greenhouse measures just 14cm x 8cm, enough for a little soil and a seedling. The removable top features a lip for easy watering. £29,50 twentytwentyone.com

60. SAVANT REMOTE

This remote connects to key entertainment services and smart-home control systems. Access your digital channels, streaming services and lighting settings with a simple voice command or few taps of the touchscreen. \$499 savant.com

64. MEVO CAMERA

Compatible with Facebook Live video streaming, the Mevo camera offers real-time editing via a companion app, and the clever ability to zoom and pan across its 150-degree angle of view to create separate 4K video feeds. \$399 getmevo.com

57. SHARKBANZ

This wristband is a boon for anyone braving shark-infested waters. It emits magnetic waves that interfere with the predators' electrical receptors, sending them swimming in the opposite direction. £70 sharkbanz.com

61. SEEK THERMAL COMPACT XR

This thermal imaging camera for iPhone and Android devices can detect heat up to 550 metres away. Use it to track wild animals on your camping holiday or for identifying missing insulation in your loft. \$299 thermal.com

65. SMARTBE STROLLER

With climate control, bottle warmer, auto-rocking, music and more, this buggy offers almost entirely hands-free baby care. Propulsion synced to your movements makes even pushing unnecessary. Seat \$3,099; bassinet \$3,199 smartbe.co

The Grow greenhouse is handmade from glass. A spout on the side also aids ventilation



54



55



56



57



58



59



60



61



62



63



64



65

67. SONY PS-HX500

Capture all the warmth and ambience of your vinyl collection in high definition with this sleek digital turntable's DSD 5.6MHz-format audio conversion. Transferred by USB to your PC or Mac, and converted to WAV or DSD files, the fine nuances of your analogue favourites can be made available for on-the-go listening. It's also a cracking turntable in its own right. £449 sony.co.uk

66. DRONE ACOUSTICS

A collaboration between designer Ruben Pater and composer Goncalo F Cardoso, *Drone Acoustics* explores our obsession with drones. Seventeen field recordings of drones, from military to consumer, are backed with an unsettling soundscape. LP £16; download £7 droneacoustics.org

Best for
ripping your
records

68. HOUSE N

Designed by Bembé Dellinger Architects, this Bavarian des res is made using exposed concrete with rough, board-marked finishes. Cantilevered decks provide views across a lake and create shade and privacy. House N is just one example of inspiring contemporary residential architecture in the Gestalten book *Infinite Space*. €44 [the book, not the house] shop.gestalten.com; bbdarch.de

Best for
living like
a Bond
villain



69

**69. NÉIT LUGGAGE**

This hard-shell luggage folds down by 70 per cent when empty to 76mm thick. A digital weight scale in the handle and TSA-compliant locks make for easy check-ins. A GPS chip helps track stray bags. *90L bag £345; 38L cabin bag £328 neit.life*

70

**70. CITROËN E-MEHARI**

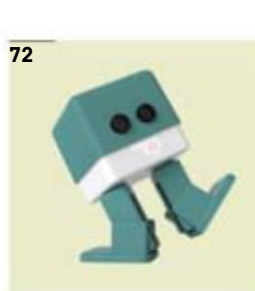
Citroën's E-Mehari drops a 67hp electric motor delivering a top speed of 107kph and a range of 200km into a fun, open-top buggy. A full recharge of the lithium polymer batteries takes eight to 13 hours from a domestic socket. *£tbc citroen.co.uk*

71

**71. SWIMS FORNO HYBRID POLO**

Classic looks give an edge to SWIMS' highly functional top, which features a hydrophobic polyester material covering on its bottom third. Sling it on while wearing wet shorts and your shirt won't take a soaking. *£60 swims.com*

72

**72. BQ ZOWI**

This bipedal bot does more than just dance. Using the intuitive visual programming tool Bitbloq, kids can link Zowi's ultrasound sensor eyes, microphone, leg motors and internal speaker to create custom action sequences. *£110 bq.com*

73

**73. ANYA HINDMARCH SPACE INVADERS**

Anya Hindmarch's AW16 handbags take inspiration from classic 8-bit gaming, with blocky, pixelated *Space Invaders* details and trippy designs. Time to level up from high-street gaming fashion. *£1,795 anyahindmarch.com*

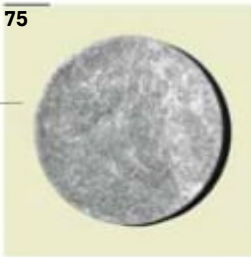
74

**74. ARTEMIDE CATA TRACK TUNABLE LIGHT**

Inspired by lighthouse focusing systems, this catadioptric track light combines mirrors and refractive lenses to produce a controllable, highly concentrated light beam. *£tbc artemide.com*

Made from a natural mineral, no two Smaller Objects Cold Coasters will be identical

75

**75. COLD COASTER**

Designed to do more than protect your tabletop, this solid soapstone coaster will help keep your drinks cooler for longer. There's no tech – just keep it in the freezer so it's ready to deploy next time gin o'clock happens to strike. *€60 shop.smallerobjects.com*

76

**76. BYREDO HANDWASH**

Byredo's duo of handwashes are the latest addition to the beauty and grooming range founded by Ben Gorham in 2006. Suede features notes of bergamot and lily of the valley, and Vetyver features mate, angelica seeds and violet. *£35 byredo.co.uk*

77

**77. EMBER MUG**

Coffee: it's always too hot or too cold. This leakproof mug uses active heating and cooling to rapidly bring your beverage to the perfect temperature, and then maintain it at a precise heat level for up to two hours. *\$149 embertech.com*

78

**78. SAMSUNG GEAR 360**

Create content for your Gear VR and Galaxy smartphone with this 360° dual-lens camera that takes 3,840p x 1,920p video and 25.9MP photos. Its single-lens mode will capture a wide-angled view in either video or stills, too. *£tbc samsung.com*

79

**79. RETINA LIGHT LUMIERE**

This flexible, cordless desk lamp's 28 LEDs provide 40 hours of glare-free lighting. Twenty-four degrees of brightness and three colour modes make it ideal for computing, reading and writing. *\$89 retinalight.com*

80

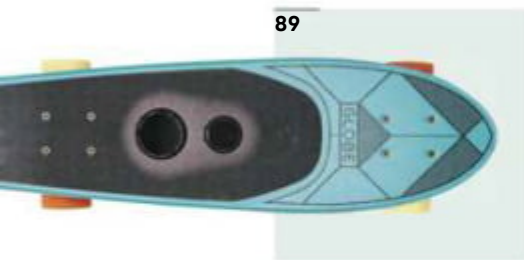
**80. SENSIBLE OBJECT'S FABULOUS BEASTS**

This stacking game has a digital twist. The plastic animals and object pieces also influence an environment in the game's companion app – until your tower tumbles. *£tbc playfabulousbeasts.com*

WIRED'S BEST SMARTPHONES FOR...



The plastic aspheric and glass spheric lenses deliver sharp images



Wide-angle deep-sea iPhone shooting

81. HTC 10

Why we love it: a 5.2in QHD (2,560p x 1,440p) screen; stunning audio with high-resolution headphones included in the box; 24-bit audio support; "freestyle" home screen where apps can be placed off the display grid. £570 htc.com

82. SAMSUNG GALAXY S7 EDGE

Why we love it: the rear is curved using 3D thermo forming; screen size has bumped up to 5.5in – but it still feels good; the display curves right to the handset's edge; it's water-resistant. £639 samsung.com

83. LG G5

Why we love it: modular capabilities include LG Cam Plus and LG Hi-Fi Plus – including a DAC tuned by Bang & Olufsen; plus dedicated accessories such as LG 360 VR headset, 360-degree Camera and LG Rolling Bot. £499 lg.com

87. DASHBON FLICKS

Who says the home cinema has to stay inside – or at home? This portable projector and sound system offers up to eight hours of 700 LED brightness. The 720hp projector delivers a 100-inch image 2.4m from the screen. \$699 dashbon.com

84. SONY XPERIA X PERFORMANCE

Why we love it: its two-day battery life; Qualcomm Snapdragon 820 quad-core processor with 32GB of memory and microSD for expansion up to 200GB; and 3GB of RAM for slick gaming. £499 sonymobile.com

85. IPHONE SE

Why we love it: the four-inch screen makes it ideal for on-the-go users who do not want a phablet – especially since Apple has squeezed the power of the iPhone 6s into this diminutive chassis. A mean feat of engineering. From £359 apple.com/uk

86. HUAWEI P9

Why we love it: a dual-lens Leica camera; a 12-megapixel sensor on each lens; great in low light conditions; manual mode; wide aperture mode for shooting close subjects; full control over the ISO and shutter speed. £449 consumer.huawei.com

88. JACKFISH SURVIVAL CREDIT CARD HOLDER

Jackfish's 11-piece arsenal is more useful than your penknife's fish descaler. A telescopic pen and hex drives provide handy utility, and a micro SD card-reader will store your travel documents. £69 jackfishsurvival.com

89. GLOBE GSB PINNER 41.25"

The world's first skateboard-cum-Bluetooth speaker has a water-resistant 50mm driver with passive radiator. It runs six hours of music per charge to provide the perfect soundtrack to your kickflips. \$299 globebrand.com

90. DARK ENERGY POSEIDON CHARGER

This 10,000mAh battery pack comes with the highest possible ratings for waterproofing and durability with a 3.4 amp output and capacity to recharge your smartphone six times. \$99.99 darkenergy.com

91. WATERSHOT PRO KIT

Capture stunning underwater photos with help from this compact housing kit for iPhone 6 Plus and 6s Plus. Pair with the *Watershot* app to share your snaps on social media – all while you're still submerged. \$220 watershot.com

92. REVO SUPERSYSTEM

The SuperSystem's solid walnut body contains a thoroughly modern stereo system including internet radio, Bluetooth and Spotify streaming. An 80W digital amp and 40W subwoofer deliver rich sound at high volumes. £550 revo.co.uk

Turn
your keys
into an
objet d'art

Left: Aesop's Protective Lip Balm provides 30 SPF without nasty chemicals. £13 aesop.com

Bottom: get organised with Nomess Copenhagen's low-key 3 Pad document stickers. £4 liberty.co.uk

93

93. PHANTOM BOWL BY JIN KURAMOTO

Fashioned from heat-pressed polyester mesh using the same technology behind car-engine oil filters, Jin Kuramoto's simple, lightweight bowls are a stylish receptacle for keys, coins and knick-knacks. Available in two sizes and in a range of pastel colours, they beat a cracked saucer or old plate hands down. £tbc jinkuramoto.com

TPE armouring, a toughened LCD screen cover and a double-locking battery housing adds extra security

Best for shooting in a sandstorm



94. LEICA X-U

The classic camera brand's first rugged model, the X-U houses a high-quality Summilux 23mm f/1.7 ASPH lens in a waterproof, shockproof and dust-proof body. The large 16.5MP APS-C CMOS sensor delivers exceptional brightness, colour reproduction and clarity, even in harsh or gloomy underwater conditions. £2,400 uk.leica-camera.com



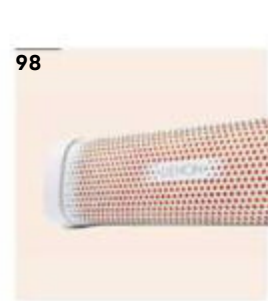
95



96



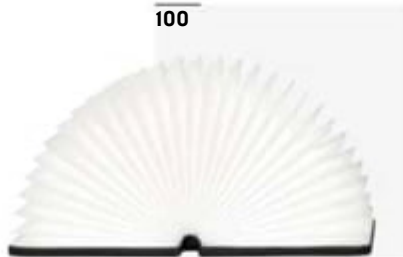
97



98



99



100



101



102



103



104



105



106

95. COLEBROOK BOSSON SAUNDERS: CUBERT

Featuring two mains outlets and two USB outlets in a small footprint, this light is smart enough to recognise and prioritise charge delivery to your primary device. £249 colebrookbossonsaunders.com

99. MEIJS MOTORMAN

An eye-catching CrMo steel frame makes this electric moped perfect for city rides. With a charge time of four to six hours and a top speed of up to 45kph, it's a pleasing combination of retro form and eco function. €5,950 meijsmotorman.com

103. PREPD PACK

With a companion app containing a selection of nutritionist-designed meal plans tailored to precisely fit neat, leakproof modular containers, this lunch box takes some of the work out of desk-dinner preparation. From \$70 getprepd.com

96. ACPAD

Packing the versatility of an orchestra into an acoustic guitar, this MIDI controller's thin polymer pad attaches to the soundboard to open up thousands of instruments, unlimited samples, two slider faders and two looping channels. €269 acpad.com

100. MINI LUMIO+

LED bulbs concealed in the spine of this mini hardback book make for an illuminating read, producing 250 lumens of ambient light diffused through waterproof Tyvek pages. An interchangeable coloured cover conceals USB ports. \$125 hellolumio.com

104. SKY Q

Sky has overhauled its set-top box, remote and UI. Pause a show in one room and pick up where you left off elsewhere, or download to a tablet for viewing on the go. But the remote, with its audible "find" function, gets our vote. From £99 sky.com

97. ARCAM MUSICBOOST

This pocket-sized DAC/headphone amp is designed to fit 6s- and 6s-model iPhones. It extracts audio from the phone's Lightning port, feeds it into a TI/Burr-Brown DAC and ramps it up to three times the original volume. £120 arcam.co.uk

101. ASTON MARTIN DB11

Only Bond gets to drive a DB10, but the elegant DB11 is the next best thing. A twin-turbocharged V12 engine makes this Aston Martin's most powerful production car ever, with a top speed of 322kph. £154,900 db11.astonmartin.com

105. BEVEL TRIMMER

A battery that delivers four hours of constant power on a single charge gives the Bevel Trimmer an advantage. Throw in oil- and water-repelling blades and a dial for edges, and you're looking at the best trimmer in the business. \$179, getbevel.com/trimmer

98. DENON ENVAYA MINI

Serving up high-quality streaming via Bluetooth aptX, this scaled-down Envaya is ideal for taking on your travels. NFC pairing means no digging around in tablet or smartphone settings. Plus you can pair three devices at once. £79 denon.co.uk

102. TOAST ALE

Turning leftover bread into beer is a worthy cause for the makers of this pale ale. All profits go to Feedback, an organisation that campaigns to end food waste. Toasted breadcrumbs make this a peppy alternative to wheat beer. £3 toastale.com

106. SONS OF LONDON SHOES

Sons of London crafts top-quality Tuscan leather shoes and sells them online for less than half the high-street cost. Every pair undergoes 150 steps in its making, from a team of Italian craftspeople. From £180 sonsoflondon.com

S

A DOCTOR'S DIGITAL ASSISTANT

Speaking at WIRED Health, Kyu Rhee, IBM's Chief Health Officer, showed off the most iconic of medical tools – the stethoscope.

The stethoscope is 200 years old. And, despite technical advances – and the rise of other techniques for examination – carrying a stethoscope makes a practitioner seem more trustworthy than any other piece of equipment, according to research.

"It's amazing how medicine still leverages this piece of technology," said Rhee. "But I believe that in the next 200 years a cognitive system like Watson™ will be a part of every healthcare decision, for every stakeholder."

IBM Watson's cognitive approach to computing absorbs data – structured and unstructured – and produces answers. To learn, IBM Watson is fed with a huge amount of existing information, then trained by experts who supply paired questions and answers. This teaches it how to interpret the mass of data it has absorbed. Asked a question without a paired answer, it then applies its understanding to generate thousands of possible answers and ranks them. The more it answers, the better it understands.

José Baselga, physician in chief of Memorial Sloan Kettering Cancer Centre in New York, listed some of the accelerating changes to cancer treatment at the launch event for Watson in the health industry.

Thousands of articles are written every year and new imaging technologies are creating better visual representations of patients' cancers. The rise of genomics has seen cancers being sequenced and patient genetics being analysed. Where a doctor in the 60s might have two diagnostic options for a set of conditions, a modern-day doctor might have 50 – with each one recommending and resisting different treatments.

To tackle this, Watson began by "reading" all the medical literature available, along with Memorial Sloan Kettering's clinical records and the reasons doctors gave for the decisions they had made. Watson's ability to read millions of pages of text in seconds, and to understand natural language gave it the ability to apply all of that learning to new cases, and to make recommendations based on that collective knowledge.

THIS SIX-PART SERIES ABOUT IBM WATSON WILL EXPLORE HOW COGNITIVE COMPUTING IS IMPACTING FIELDS AS DIVERSE AS FINANCE, EDUCATION AND SECURITY. THE FIRST TOPIC FOR DISSECTION IS HOW WATSON IS EMPOWERING DOCTORS GLOBALLY
WIRED.CO.UK/IBM-COGNITIVE-INSIGHT

**'IT'S THE
INTERPLAY OF
DATA QUALITY,
CONTROL AND
GOVERNANCE
THAT MAKES
WATSON HEALTH
AN INTERESTING
PROPOSITION'**

Matt Howard, Watson Health European lead

For example, looking at data from a young patient with lung cancer, Watson recommended a molecular analysis – reasoning that the tumour may have mutations that would affect the choice of treatment. When analysis was delivered, a mutation was found on the epidermal growth factor receptor.

To deal with this, general medical guidelines recommended a treatment of the drug erlotinib. However, a recent paper had demonstrated that, out of all the possible EGF receptor mutations, one did not respond to erlotinib – the one in this case.

Perhaps ten physicians in the world would have been aware of that new research offhand. It's an example of augmented intelligence – a human decision being supported and enhanced by Watson's immediate access to and mastery of medical literature.

Memorial Sloan Kettering, where Watson is being "trained", is at the forefront in the global fight against cancer. However, because Watson is cloud-based, it can be made available throughout the world.

Cognitive health goes beyond hospital stays or medical interventions, however. And, with the right equipment and the right data protection, a cognitive approach to health can work 24 hours a day to extend and improve life. Data, and the ability to interpret it, may be the most powerful medicine of this century – and, by opening up new ways to understand the patient, Watson may be this century's stethoscope – a transformative technology made commonplace. ibm.com/outthink/uk

"In a country like the US or the UK, cancer care is highly specialised," said Rhee. "In developing countries you may have a smaller number of oncologists who have to deal

When you think of medical data, the first image is of medical records. In April, a New Jersey man's fitness tracker may have saved his life. After he experienced a seizure at work, heart rate data from his smartphone helped doctors rule out potential diagnoses and deliver vital treatment more quickly.

Watson is working with Meditronic, a medical equipment maker, to help the 400 million people affected by diabetes. Meditronics' vast data sources, from patients' insulin pumps and glucose monitors could help track their users' health.

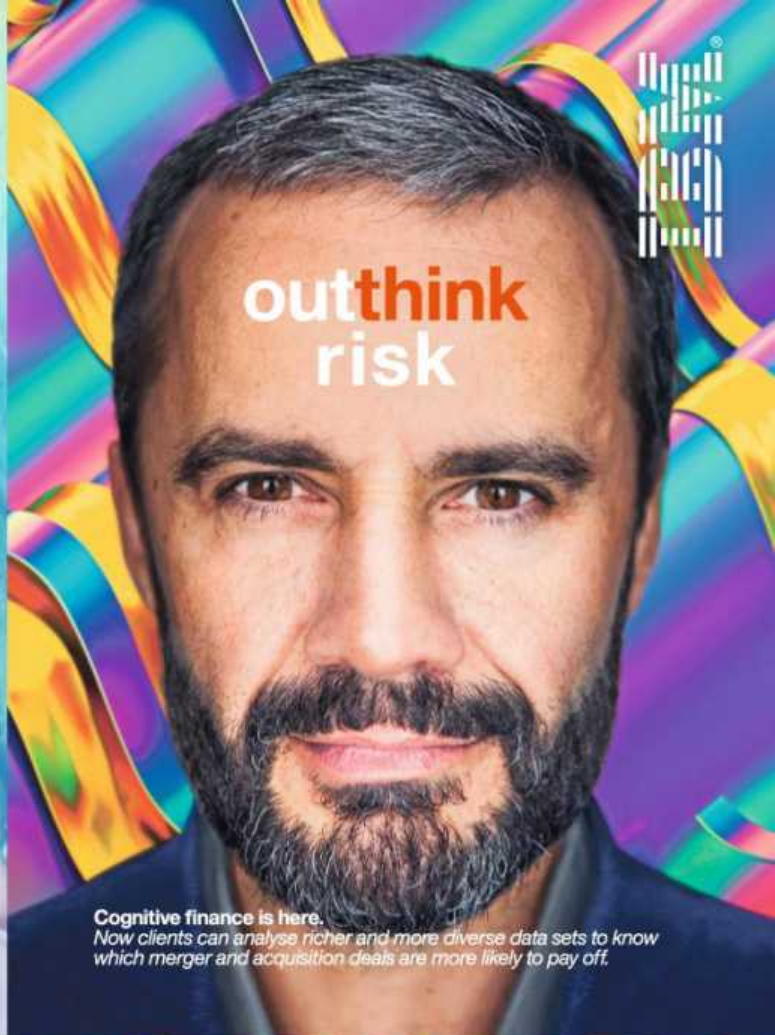




outthink trends

Cognitive inventory is here.

Now retailers can combine predictive analytics with demographic data to make sure hot items stay stocked in the right styles, colours, and sizes.



outthink risk

Cognitive finance is here.

Now clients can analyse richer and more diverse data sets to know which merger and acquisition deals are more likely to pay off.



outthink threats

Cognitive security is here.

Now banks can accurately detect new fraud patterns and combat fraudulent events as they happen.



outthink cancer

Cognitive oncology is here.

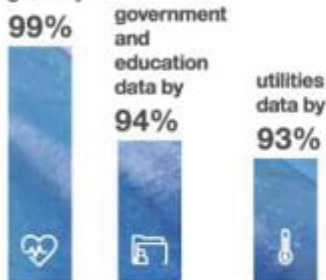
Now doctors can use Watson to analyse patient data against clinical expertise and external research to help identify the best course of treatment.

A cognitive business is a business that **thinks**.

A new era of technology is giving rise to a new era of business, made possible by three historic shifts:

1. A world awash in data.

80% of all data is invisible to today's computers. Now consider that by 2017 healthcare data is expected to grow by



2. A world reinvented in code.

Take just one example: a car is now a platform for software, containing

100 million lines of code—93 million more

than advanced passenger jets.

3. The advent of cognitive computing.

Technology that takes in data in all forms – including unstructured – and understands it, learns from it and reasons through it. This is what business has been waiting for. IBM Watson™ now works with over 70,000 developers and 350+ partner companies who have launched 100 cognitive applications

Digital is not the destination but the foundation for a new era of business; we call it cognitive business, and IBM Watson is the platform. Today Watson is helping doctors reimagine medicine, and leaders reshape industries as diverse as retail, banking and travel. And Watson is taught by industry experts, so their know-how can reach more practitioners.

Cognitive business **is here**.

Cognitive engagement.

In government: Watson is helping cities run better. Working with a startup, Watson's question answering and natural language capabilities let users ask common questions – "How do I find a lost pet?" and "How do I pay a parking ticket?" – without waiting on the phone or for an email reply.

Cognitive deepens engagement.

Cognitive processes and operations.

In travel: A new travel startup is teaching Watson how to help travellers find personalised recommendations through thousands of sources, user data points and local area knowledge. The company is already transforming the travel process, from inspiration to destination.

Cognitive brings more certainty to business.

Cognitive exploration and discovery.

In science: Working with a leading medical school, Watson helped scientists identify six proteins that modify p53, a protein related to many cancers. It typically takes the life science industry years to accomplish what Watson did in mere weeks.

Cognitive is accelerating high-stakes research.

Cognitive products and services.

In media: A leading broadcast network grew viewership through look-alike modelling, ratings and streaming data analysis. They saw faster, more accurate ratings predictions, in some cases six weeks in advance of a show's release.

Cognitive products never stop adapting.

Cognitive expertise.

In law: Watson is being trained in legal language and natural language, so it can help answer legal questions framed in ordinary speech. Now being piloted in 20 of the world's top law firms, Watson can help cut research time from hours to seconds.

Cognitive elevates expertise.



1 2



3 4

The future of medicine, according to Junaid Bajwa, director of healthcare services at healthcare provider, MSD, "lies beyond traditional lotions and potions," with digital tools that can help people prevent themselves getting ill.

The 125-year-old company has guided hundreds of therapies through the tough regulatory landscape of clinical trials, but it's less equipped with the likes of growth hacking and UX design. That's where Velocity Health comes in. The healthcare accelerator, launched in partnership with Telefónica Open Future's Wayra UK, aims to connect MSD with entrepreneurs, and provide startups with up to £64,000 in initial funding, plus mentorship.

"Startups often struggle to gain access into the NHS and to the patients they need to validate and improve their technology in a clinical setting," says Wayra director Gary Stewart. "Our aim is to build the infrastructure to allow them to flourish."

The first Velocity Health companies, which exhibited at WIRED Health on April 29, were selected on the theme of preventative medicine. Rockwell Shah, CEO of sleep-enabling app *Pzizz*, reckons tiny lifestyle changes can have a huge impact on people's wellbeing.

"About 30 per cent of the world's population suffer from poor sleep," he says. "That can lead to higher diabetes incidence, poor heart health and even relationship problems."

Other Velocity Health startups focus on expanding the physician's reach beyond the hospital, such as *TickerFit*, which allows remote monitoring of prescribed exercise regimes, or *Aparito*, which supports early diagnostics for children, without scary hospital tests.

Preventing illness can begin even earlier than that, says Melinda Nicci, founder of the London-based maternity health information platform *Baby2Body*.

"Studies have shown that optimising a mother's health during pregnancy



VELOCITY ACCELERATOR GAINS PAGE

MSD AND WAYRA UK'S VELOCITY HEALTH IS ASSISTING FAST-GROWING TECH STARTUPS WITH MENTORSHIP, FUNDING AND EXPERTISE

helps protect their baby against diseases such as obesity and high blood pressure later in life."

While MSD takes no equity in the startups, Bajwa has seen the benefits of the accelerator in challenging him to rethink preventative medicine.

"There are plenty of startups in the nutrition and wellbeing space, but we wanted to see what else prevention could involve," he says. "What we've found is a fascinating group of individuals who are all defining it in different ways."

See wayra.co.uk/velocityhealth

VELOCITY HEALTH STARTUPS

VELOCITY HEALTH

The healthcare accelerator, in partnership with Telefónica Open Future's Wayra UK, aims to connect the healthcare provider MSD with entrepreneurs.

1. ROCKWELL SHAH

The *Pzizz* app combines a soothing voice with binaural soundtracks, generated based on research into psychoacoustics, that calm the mind and induce deep sleep.

2. AVRIL COPELAND

Copeland's *TickerFit* app allows healthcare professionals to continue to prescribe exercise and monitor patient activity remotely once they've left the hospital.

3. ELIN HAF DAVIES

Aparito, founded by Elin Haf Davies, works with available wearable devices to provide continuous passive monitoring in a real-world environment.

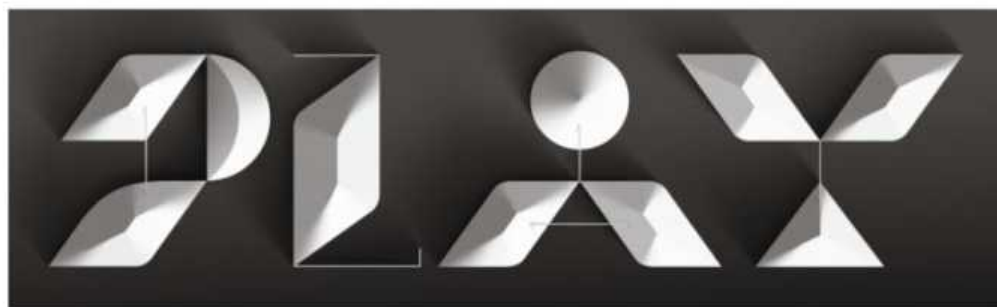
4. MELINDA NICCI

Informed by Nicci's sport psychology degree, the *Baby2Body* website and app delivers advice, support and motivation to more than 185,000 mothers.

Google's gigapixel Art Camera reveals hidden details in Vincent van Gogh's *The Starry Night*, such as these bare patches of canvas, only visible at close magnification. They may indicate that he painted it in a rush of activity



WIRED CULTURE / EDITED BY OLIVER FRANKLIN-WALLIS / 099



Search for inspiration

Inside Google's plans to make museums' archives accessible to the whole world



At the Google Cultural Institute in Paris, Charlotte Fechoz is admiring Vincent van Gogh's *The Starry Night*. The painting, of course, isn't here; it's been in the MOMA in New York since 1941.

Instead, Fechoz – the co-ordinator of Le Lab, as the Paris workspace is known – is viewing the masterpiece on The Wall, an 18m-wide, two-storey-tall screen designed for viewing artworks at massive scale. *The Starry Night*, one of hundreds of masterpieces to have been scanned using Google's gigapixel Art Camera, is blown up to astonishing clarity. >



This is a stone capital featuring winged animals, made in around 1250. It is currently in Barcelona's Museu Episcopal de Vic, but it's also one of thousands of works in the Google Cultural Institute's archive, displayed here by year at TED 2016



"You can see the canvas has not been fully covered," Fechoz says, zooming in until a single brushstroke is rendered at twice her size. "According to experts, that means van Gogh painted this in a rush. He had this feeling of necessity."

If Google's core search business is comparable to that of a library – to collect and organise all known information – then the Cultural Institute is its art gallery. "We try to provide access, and we try to preserve," says Laurent Gaveau, the 39-year-old director of Le Lab. The nonprofit platform, he says, has a single mission: "How can people be more engaged with art?"

Launched in 2011 as the Google Art Project, the Cultural Institute sprang from a handful of "20 per cent time" projects by employees across Google's

internal departments. Since broadened to include historical archives, street art and performing arts, it contains more than six million artworks, photos, videos and documents from 1,000 institutions worldwide, including the British Museum and MoMA.

At first glance, Amit Sood, the Bombay-born director of the institute, makes an unlikely champion for the arts. "I have zero background in art or history," says Sood, sitting in his London office. Growing up in India, Sood never went to museums. Only after moving abroad, doing engineering jobs in New York, Stockholm, Singapore and Belgium, did he become obsessed with museums as the best way to connect to his new bases. "I found it a very cost-effective way of keeping myself entertained."

At Google, Sood's experience initially prompted him to get in touch with museums in the hope of bringing their collections online. But persuading centuries-old institutions to open their collections initially proved difficult. "There were three or four barriers to trust. The first one is: it's Google, you're going to come, take all this stuff and splash ads on it," says Sood. The Cultural Institute was created as a non-profit; arts institutions are responsible for uploading their own content on to the site and retain control of copyright. "They choose what goes on the platform, we don't." (The latter is significant, given the recent copyright controversy around Google Books – challenged by authors claiming the scanning of their works amounted



Above: a three-dimensional artwork created in virtual reality using the *Tilt Brush* app. The artist "paints" in the virtual space using a motion- and location-sensing controller, while wearing an HTC Vive headset

Right: Amit Sood, director of the Google Cultural Institute, delivering his TED 2016 talk on using technology to put not only artworks online, but entire museums, to be explored in 3D VR



to outright infringement rather than fair use, the US Supreme Court ruled in Google's favour in April. Google's arguments included that they made the books and academic papers more discoverable, without making the entire text available online.)

Another fear: that putting art online would reduce footfall in museums. "We worked very hard to debunk this," says Sood. "The only way we could do it was wait. *The Art Newspaper* reports year-on-year records in museum visits."

The visitors debate, Sood says, also illustrates a gulf between big-name tourist attractions and smaller institutions. "When you talk to museums in remote areas, they're like 'sure'," explains Sood. "Their problem is that people don't know about them."

IN

Paris, Gaveau's team is developing tools to help audiences experience art in new ways. One of its first developments was the gigapixel Art Camera, which stitches together hundreds of up-close images to capture artworks in astonishing detail. The tool has captured dozens of works, from Munch's *The Scream* to the Chagall-painted dome of the Paris Opera. (The latter presented a particular challenge: the ceiling is obscured by an ornate chandelier, circumvented through innovative image stitching.)

The results aren't just visually impressive. "Curators come here to study paintings they have been studying for 30 years," says Fechoz. A recent scan of St Paul's Cathedral dome gave close-up access to work unattainable even to historians.

The institute has also pioneered indoor Street View, which began when Sood approached the Google Maps team to try to capture inside of galleries. The result: a custom-built 360° camera rig atop a moveable trolley, which enables virtual gallery tours. Since 2015, its archive has expanded to include live events such as the Venice Biennale. "For the Grand Palais in Paris we did flying 3D capture, the trolley, the Trekker backpack for the stairs," recalls Gaveau. "We even put a tripod on the roof."

Other creations are focused on discovering art in alternative ways. "We have this database of millions of great assets, and we try to find ways to create new experiences," says Gaveau. One particularly entertaining prototype is



Portrait Matcher, which uses a webcam to analyse viewers' facial position and match it to one of the artworks in the database in real time. It's like a fine-art mirror; for kids, it could be a new way into otherwise dry areas of art history.

Some of Le Lab's work has had impact far beyond Paris. Cardboard, Google's low-cost VR headset, began as an experiment by Damien Henry and David Coz, two engineers working in the institute's Paris lab. (The lab's workspace is furnished in cardboard, a tribute to its most famous creation.) "From the beginning, education and culture were at the core of the project," explains Henry. "And now one million children get to experience VR in the classroom." In December 2015, the institute used Cardboard to launch performing arts on the platform, shooting VR films inside the Royal Shakespeare Company and Carnegie Hall.

In March, in partnership with the Royal Museums of Fine Arts of Belgium, Sood's team created a VR version of Bruegel's *The Fall of the Rebel Angels*. "The idea is to step inside a painting," Henry says. "To make a connection between you and a piece of art."

But Sood's vision goes beyond documentation. The lab is also experimenting with what the future of art might look like. In March 2016, Sood's team invited five world-renowned street artists to the lab to play around with *Tilt Brush*, a VR painting app (which Google acquired in 2015) for the HTC Vive. "We decided to pick street artists at the beginning, because they know already how to draw in this very physical way," says Henry.

Inside *Tilt Brush*, WIRED watches as the paintings are conjured in mid-air. Sketched outlines, with the addition of colour and shadow, become tangible objects floating in 3D space. Light and texture fill the previously blank room. Moving around inside each piece as they're being created – elaborate calligraphy galaxies, ornate mask sculptures,

an exploding metal landscape bursting with light – feels remarkably like being inside an artist's mind. It's hard not to witness the *Tilt Brush* paintings in progress and not suspect one might be witnessing the birth of a new art form.

The *Tilt Brush* experiments are not part of any Google master plan. For now, they're just a glimpse of what could be. "We want the lab to be the place where we can do things that don't have an immediate takeaway," Sood says. (In April, the artworks were made available for those who own an HTC Vive; they're already planning to invite more artists to experiment with the app.) The same goes for its artists-in-residence programme, which includes a partnership with a young-artist initiative, 89plus, and has hosted the novelist and artist Douglas Coupland.

Increasingly, he says, the Cultural Institute isn't just moving art online; it's also moving into galleries. Portrait Matcher, The Wall and Cardboard have all been developed with physical spaces in mind. In Brussels, Cardboard headsets showing the Bruegel film are as much part of the exhibition as the physical paintings on show.

"We want to be a bridge between the cultural sector and advanced technologies like VR," says Sood. "Museums don't have a lot of money. We can be a place that can fund and source these type of experiences."

That might be the Cultural Institute's biggest impact – exposing age-old institutions to disruptive ways of thinking about art, just as it is showing the role of art to those inside one of the world's biggest tech companies.

"People have too myopic a view of what art and culture is," Sood says. "For some people, a very long curatorial narrative on impressionist art will not work. But if I say: hey, you want to see what bling used to be like in 1800? I think there's a lot of opportunity for disruption, for changing people's minds."

OF-W google.com/culturalinstitute



Together with
BBVA

23.06.16

WIRED'S ONE-DAY EVENT UNPICKING THE TECHNOLOGIES, BUSINESSES AND PEOPLE IMPACTING MONEY, BANKING AND FINANCE RETURNS FOR ITS FOURTH YEAR. JOIN US AND MEET THE THINKERS, MAKERS AND DOERS DISRUPTING THE SECTOR
BOOK YOUR TICKET NOW WIRED.CO.UK/MONEY16

THE BRITISH MUSEUM, LONDON

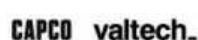
START UP STAGE
PARTNER



LEGAL
PARTNER



EVENT
PARTNERS



TICKETING
PARTNER



17 MAIN STAGE SPEAKERS INCLUDE:



PAULO MARQUES
Marques' data science firm Feedzai uses machine learning to prevent fraud for payment networks, banks and retailers.



CHRISTINA KEHL
Co-founder of mobile-first insurance broker, Knip, Kehl also helped launch an association of more than 70 Swiss fintech startups.



SHAMIR KARKAL
Karkal aims to open up BBVA's core banking platform, to allow people to build products and services on top of them.



HARDEEP WALIA
Walia's Motif enables investors to build portfolios around broad themes, such as natural resources or biotech.



MARTA KRUPINSKA
Azimo, co-founded by Krupinska, is a low-cost and safe way to send money across borders to 195 countries.



AMOS MEIRI
Bitcoin entrepreneur Meiri co-founded Colu – a platform using the blockchain to bring trust to digital and physical transactions.

HEALTH | MONEY | 2016 | NEXT GEN | RETAIL | SECURITY | ENERGY

Artist Conrad Shawcross finds beauty in machines. His mechanical sculptures – constructed from steel or wood and brought alive with motors, lights and cogs – pay homage to inventors, mathematicians and scientific pioneers.

His ongoing *Ada Project* (named after Ada Lovelace), for example, is a hacked welding robot that dances, creating mesmerising light patterns. Musicians live with the robot for a week, creating music in response to its choreographed movements. *Timepiece* explores celestial timekeeping, and his *Paradigm* series is based on the mathematics of tetrahedrons.

Shawcross's latest work is *The Optic Cloak*, a 49m-high structure on the 600,00m² Greenwich peninsula in London. Debuting later this summer, it's actually a chimney flue, part of Greenwich's low-carbon energy centre, and coated in a new dynamic surface.

"My proposal was quite radical in that it removed the entire frame surrounding the chimney and replaced it with a much lighter, more efficient one," explains the 38-year-old. "It has a triangulated structure with perforated panels, forming a translucent skin that allows the wind to pass through it."

Looking at ways of visually breaking up a flat surface, Shawcross took inspiration from camouflage techniques and a mathematical optical phenomenon known as the moiré pattern. "The paradox of camouflage is that on one level it's trying to make something disappear, but on another level it becomes very arresting and visible."

Shawcross experimented with old-fashioned techniques: folding paper as well as looking

at the effects of angle, opacity and hole sizes. He also used digital modelling in Cinema 4D.

"London is littered with incredible, iconic chimneys and it's a real legacy of the city," says Shawcross. "It's still primarily a flue stack, but by using an interesting piece of design, it's hopefully a beautiful landmark on the horizon too." **Kevin Holmes**
conradshawcross.com

LONDON'S MAKEOVER ARTIST

Inspired by camouflage and cubism, artist Conrad Shawcross is refashioning the Big Smoke's skyline

STACKS OF TALENT / PLAY / 105



PHOTOGRAPHY: CHARLES EMERSON

Main image: artist Conrad Shawcross with parts of *The Optic Cloak*

Right: how the finished chimney will look in situ in Greenwich, London





No Man's Sky, out June 22, may be the biggest game ever made: an entire universe of 18 quintillion procedurally generated planets. To score something so impossibly vast, developer Hello Games turned to Sheffield-based math-rock band 65daysofstatic. "Procedurally generated music is something we've been interested in for a while," says band member Paul Wolinski. "But the way it tends to play out is that most generated stuff in computer games tends towards ambience: quite granular, soft, synthy stuff [because] the music's never quite sure what action it's about to be soundtracking." With a game as

sprawling as *No Man's Sky*, that problem increased exponentially. "We decided on a two-pronged attack," Wolinski says. "We recorded linear stand-alone compositions, because we want the record to be worthwhile in its own right, but at the same time we collected a big sound library of individual sounds, instruments, melodies and beats." Like *No Man's Sky*'s in-game planets, the music is procedurally generated from the band's

recordings as players move through the universe – it's composition by algorithm. For the band, Wolinski says, creating *No Man's Sky*'s soundscape has been energising, allowing them to experiment and explore new musical spaces. The band will release the music as a concept album on June 12. "We really enjoy being the kind of band that turns up where people don't expect bands to be." **Matt Kamen**
no-mans-sky.com

HOW TO SCORE AN INFINITE UNIVERSE



Simone Giertz is not your average roboticist. The 25-year-old inventor and comedian is, she explains, "probably the world's only professional shitty robot builder." Giertz's GIF-friendly creations, such as a robot arm that attempts (and invariably fails) to serve breakfast, or scrawls lipstick all over her face, have accumulated more than eight million YouTube views and led to a growing viral fanbase.

A shitty robot, says Stockholm-based Giertz, "is one that solves a problem that doesn't exist, or solves a problem that does exist, but in a bad way". Her creations are built for laughs – witness a helmet that brushes your teeth and an alarm clock that violently slaps you awake with a rubber arm. (The latter has been viewed more than a million times, and nearly ripped out the Swede's hair.) Her Popcorn Feeding Helmet, pictured here, was created with *MythBusters*' Adam Savage.

After quitting a physics degree and flitting between a number of roles at startups and in tech journalism, Giertz settled on YouTube. Each creation requires spending weeks at a time painstakingly repurposing household objects for comic effect.

But being robo-slapped isn't just for laughs: on the contrary, Giertz says, her aim is to inspire more would-be inventors. "People think it's about the robot uprising, or a commentary on people being so lazy that they can't even make themselves breakfast," Giertz muses. "Electronics are getting more and more accessible now – you don't have to be an engineer to start building things. I really want to spur [on] that democratisation of technology."

As to why her blend of comedy and maker culture has taken off so wildly, there's a simpler explanation. "The internet is weird," she chuckles. **Sam Rowe** *simonegiertz.com*

Mistress of malfunction

Comedian Simone Giertz is making impractical robotics viral. Cue Applause Machine...



WIRED'S FAVOURITE GIERTZ GADGETS



Wake-up Machine

An alarm clock attached to a rubber hand powered by a 165rpm brushless DC motor, this gives its human a friendly slap.



Applause Machine

A pair of tongs with rubber hands attached, the mechanism claps – badly. Best used sarcastically, eg when another bad robot breaks down.



Chopping Machine

Two kitchen knives lifted by a servo mechanism and springs, and controlled by an Arduino nano. Warning: best not used at home.

In a bulletproof arena in Glasgow, the air rings with the sound of flamethrowers and metal ripping metal. A pit awaits the carcasses of mangled machines. *Robot Wars* is back.

It's been 14 years since the BBC series ended, so the show's house robots – which surround the arena looking to scalp the wounded – have received upgrades to make them faster, harder and more dangerous. Fan favourites Matilda, Shunt, Dead Metal and Sir Killalot have all been recreated from scratch for the new series. “We knew the old house robots were not up to the job,” says James Cooper, director of Birmingham-based Robo Challenge, which redesigned the machines. “When you look at the leap from the previous series, the competitor robots would have them in parts straight away.”

The new Sir Killalot weighs 750kg, has 5cm-thick steel armour and can lift 40 tonnes. Its left arm, which weighs 130kg and is heavier than any competitor robot, had to be lifted into place by a forklift. Cooper – a former competitor on the show – explains that a single motor in Dead Metal is more powerful than its entire previous form. Matilda, which has had its chainsaw replaced with a spinning hardox wheel, is “one of the most dangerous robots out there,” says executive producer Andrew Robertson.

However, they are not infallible: during one round, WIRED watched as competitors ignored each other and attacked the house bots, with more than one of them being immobilised, a feat the series had never seen before. “We couldn't build house robots that wouldn't get flipped over, unless they weighed two to three tonnes,” Cooper, 30, explains. “The power you get in the flippers means it is unviable.” In other words: they may have won this battle, but wait for the war. **Matt Burgess** *Robot Wars* will be shown on BBC2 this summer

THREE, TWO, ONE... REACTIVATE!

To reboot *Robot Wars*, the BBC needed to upgrade a few of its old favourites



ILLUSTRATION: MATTHEW LYONS

108 / PLAY / DROID RAGE / PARENTAL GUIDANCE

YOUR CHILDHOOD, REBOOTED

Want your kids to love the same films you did? Head to the cinema this month, where rebooted childrens' classics are this summer holiday's must-sees. **WIRED** breaks down the new(ish) versions. OF-W

THE BFG



- Roald Dahl. Never fails
- Spielberg-ian magic
- CGI Mark Rylance

THE LEGEND OF TARZAN



- Do we *really* need another Tarzan?
- Shirtless Alexander Skarsgård

GHOSTBUSTERS



- Misogynists' nightmare
- Fan service
- Bill Murray cameo!



WIRED 2016

03-04.11.16

A TWO-DAY EVENT SHOWCASING THE BEST OF THE WIRED WORLD – THE GREATEST INNOVATORS, THE MOST RADICAL THINKERS AND THE NEWEST TECHNOLOGIES. EXPECT MORE THAN 50 SPEAKERS, LIVE PERFORMANCES AND THE TEST LAB

BOOK YOUR TICKET NOW WIRED.CO.UK/16

TOBACCO DOCK, LONDON

50 MAIN STAGE SPEAKERS WILL INCLUDE:



CHRIS TURNER
UK comedian and lightning fast freestyle rapper, Turner has more than 2.5 million video views on YouTube.



JO BERRY
Berry's father was killed by the IRA's Brighton bomb blast. She now runs the Building Bridges for Peace NGO.



PATRICK MAGEE
Former IRA member Magee was released from prison in 1999. Today he works with Jo Berry's Building Bridges for Peace.



SHEELIKA RAVISHANKAR
Team Indus aims to land a spacecraft on the Moon by 2018. Ravishankar is building its workforce.



TAAVET HINRIKUS
Hinrikus was Skype's first employee before co-founding TransferWise – one of London's few unicorn startups – in 2011.



THOR BJÖRGÓLFSSON
The Icelandic investor who made billions, lost everything, then made it all back, shares his philosophy.

HEADLINE PARTNER

Telefonica

TICKETING PARTNER

Eventbrite

HEALTH | MONEY | 2016 | NEXT GEN | RETAIL | SECURITY | ENERGY

THE MASTER OF SYNTH CINEMA

From *Drive* to *The Knick*, composer Cliff Martinez brings the darkness

Whereas most film composers assemble orchestras, Cliff Martinez just needs a laptop and a keyboard (although he's playing a Cristal Baschet here, *right*). The former Red Hot Chili Peppers drummer's stark, synth-heavy soundtracks for the likes of *Sex, Lies and Videotape*, *The Knick* and *Drive* have made him a go-to for directors with a dark side. Martinez, 62, has just completed the score for *The Neon Demon*. Out on July 8, it's his third film with *Drive* director Nicholas Winding Refn. Here Martinez talks to WIRED about composing, Kraftwerk, and the value of long-term creative collaboration. Olly Richards

WIRED: Your scores are very distinctive. How did you find your particular sound?

Cliff Martinez: My style has a lot to do with the fact I did at least half a dozen films for Steven Soderbergh before I worked with any other directors. His whole approach was "less is more" – and when there was music it should mean something. He liked the instrumentation sparse. Also, his films were very low budget, so working electronically rather than orchestrally was probably a function of that. Plus, of course, I'm a rock 'n' roller. I don't have orchestral training in my background.

How has your collaboration with Nicholas Winding Refn developed?

My best material comes from repeat business. The only other person I have that relationship with is Steven Soderbergh [with whom Martinez has scored ten projects]. The relationship becomes deeper. Usually you get hired when the film is finished, as was the case on *Drive*. On *The Neon Demon*, we began talking about ideas and brainstorming very early on in the process, before it was even written.

How does *The Neon Demon* compare to your other work?

Well, the soundtrack isn't as dominated by songs the way *Drive* was. There's significantly more music than was in *Only God Forgives*. There's not so much of the ambient texture here as there was on *Drive*.

Once you know that you'll be scoring a film, what's the first thing you do?

I like to fast forward to a theme that seems to be representative of the whole film. If that's proving difficult, I'll go to a scene that inspires something musically, or shut the film off and start writing based on my general impression. I rarely go chronologically. In *The Neon Demon* there was a scene that Nicholas described as a turning point. I scored that first, but Nicholas didn't care for it. So sometimes starting with the most ambitious part of the movie is a mistake. The theory is that if you knock that out then you've got some universal theme or motif to lead you to the rest of the film. On the other hand, if you get it wrong then your whole foundations are off. So I went back to a smaller step and built to the big crescendo.

What's your set-up while working?

Mac Pro 8-core, three Mac Cinema displays, Ableton Live, Native Instruments 61-key KOMPLETE KONTROL keyboard, MOTU 2408 audio interface, MOTU midi express 128 midi interface.

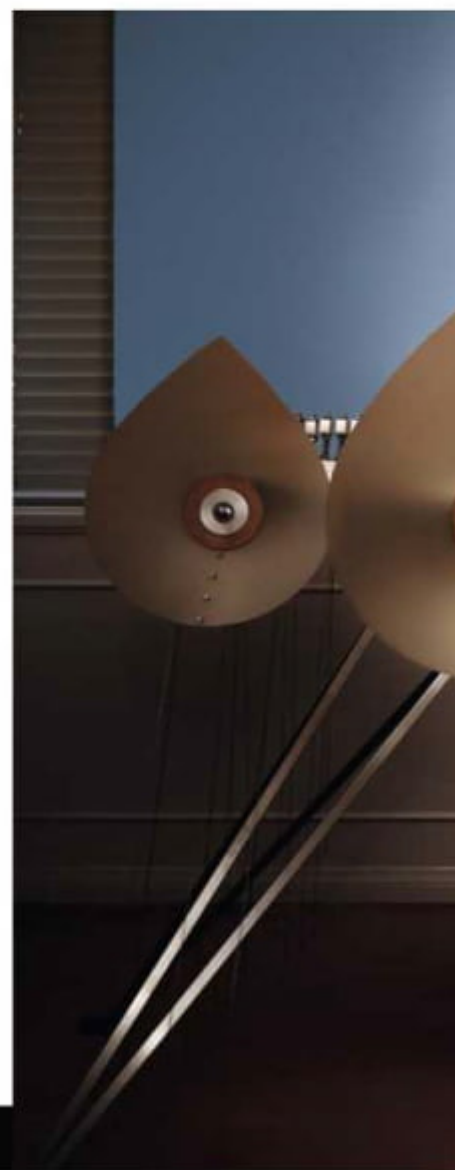
What do you consider your genre?

I get calls to do the dark, psychological stuff; films where people get stabbed and blown up and in car crashes. It's not a specific genre – but if it's dark, then I'm often on the shortlist.

What was the first film you saw where you really noticed the score?

There were two. My parents took me to the drive-in when I was a little kid, to see *A Fistful of Dollars*, scored by Ennio Morricone. I was so excited by the music that my parents bought me the soundtrack album. Also, a show on NBC called *Saturday Night at the Movies*

PHOTOGRAPHY: SPENCER LOWELL; ILLUSTRATION: JOE WALDRON



used to play *The Day the Earth Stood Still* several times a year and every time it came on I watched it. I realised much later it was Bernard Herman's score with the theremin that was so great.

***The Knick*, Stephen Soderbergh's TV series which you score, is set in the early 1900s but has a very modern soundtrack. Why?**

At first it didn't feel like a logical fit to me. I emailed [Soderbergh] and said, "Are you sure you want this harsh electronic score?" We tried to make it primitive, the dawn of electronic music, like the show is about the dawn of the Industrial Revolution. I was digging out synthesisers that sounded like the early days [the 60s and 70s]. That Kraftwerkian sound that I was striving for. At first it was like sticking a square peg in a round hole. Eventually, if you pound hard enough, it goes in.

**Films of note
Three top scores
from Martinez**

SOLARIS (2002)
Soderbergh said the music was as key as the imagery

DRIVE (2011)
The dark, pulsing electro is its most memorable feature

THE KNICK (2014)
Martinez gives the period setting a Kubrickian edge

You also composed for the video game *Far Cry 4*. How do you write a score for an open narrative?

I have no idea how *Far Cry 4* turned out – I try to play it and about 30 seconds in I get my head shot off. I depend on the picture for structure – it creates the parameters you write within. With those gone, you're just creating isolated tracks that all fit with one another, so if you subtract one it still all works. It's like building a do-it-yourself kit, so the computer can put things together on the fly. I think in the future, video games will cause very interesting changes in the art of composing music. At the moment it just adds and subtracts. I think eventually games will compose their own melody and harmony, relative tension, empathy, dynamics.

What haven't you done yet?

A comedy – where nobody gets shot.



MUSIC OF THE AGES

Peter Holmes, an academic at Middlesex University, is recreating ancient musical instruments with the help of artefact fragments, a 3D printer and an obliging metalworker.

"I've just been making some auloi," says Holmes, 76, referring to a type of pipe that the ancient Greeks played two at a time, one in each corner of their mouths. "They're each about a metre long. You'd need serious lung power."

Holmes's archeoacoustic work is part of The European Music Archeology Project, a multimillion-euro attempt to recreate not just the sounds of ancient Europe, but also the environments in which the instruments would have been played – from Stonehenge to prehistoric burial chambers. A June 2016 exhibition in Ystad, Sweden, will let visitors see and hear the results (it reaches the UK in 2018).

"When you play these instruments, it's magical," Holmes says. "You think of everyone who played them thousands of years ago. It makes you realise just how much we have in common with the past." **Alex Marshall**
emaproject.eu



TREND DECODER



BREAKOUT TREND: ESCAPING

Production company Little Lion Entertainment raised £933,798 on IndieGogo to make *The Crystal Maze*, currently the largest known room escape

136

The number of room-escape experiences in the UK, according to Escape Room Directory; up from 30 in January 2015

You're locked in a room with a group of strangers and no time to lose.

Desperate to escape, you search for clues that will – hopefully, eventually – lead you to freedom. Then you leave, collect your receipt, and perhaps pay to go again. **Across the UK**, a new trend is breaking out: breaking out. This summer's hottest escape-the-room ticket, **The Crystal Maze** – a crowdfunded live adaptation of the 90s TV series – is just one player in a rapidly expanding niche.

From clueQuest to Breakout and HintHunt, experiences and startups are popping up across UK cities.

The genre's rise can be traced back to 2011, with the launch of ParaPark in Budapest. Initially inspired by online games such as 2004's *Crimson Room*, with subsequent titles such as 2012 iPhone hit *The Room* cementing escape's broader popularity, the live experience soon came to the UK. Escape Hunt, now one of the largest escape-the-room startups, will soon be in 60 cities worldwide. "People don't want to just sit there and watch a film, they want to interact with their environment," says founder Paul Bart. The format's **low cost**, crowdfunded business plans and viral marketing through TripAdvisor rankings have contributed to its success; so has a growing appetite for immersive experiences such as Punchdrunk and Secret Cinema. The advertising industry is catching on, creating similar experiences for brands. And, as the movement scales up, expect the sets to do the same – after all, done well, escape-the-room games can be pilots for more ambitious all-enveloping projects. The next thing to break out of its cell might just be the genre itself. **OF-W**



FIVE MUST-ESCAPE GAMES:

- HintHunt
- Breakout
- Manchester
- Escapologic
- Dr Knox's Enigma
- The Crystal Maze

"You can just convert your second bedroom into an escape game, or rent a space," says Bart. It's a low cost of entry compared to large-scale experiences

SIEMENS / WIRED PARTNERSHIP

YOUR FUTURE FRIDGE

SIEMENS' NEW
GENERATION OF
APPLIANCES IS
MAKING MODERN
LIFE EASIER.
ANOTHER STEP ON
THE ROAD TOWARDS
THE FUTURE,
THE INTELLIGENT
AND CONNECTED
APPLIANCES
WILL CREATE A
HOME YOU NEVER
KNEW YOU NEEDED





INTEGRATED WI-FI:

Think Wi-Fi is just for computers? Think again. The Siemens iQ500 refrigerator has in-built Wi-Fi, and will send you a notification if the door is left open. You can change the fridge temperature remotely and access information, such as manuals, via its digital interface

HOME CONNECT:

Whether around the house or on the move, you can always be sure of what's in your fridge. Simply open up Siemens' *Home Connect* app to see what's inside, thanks to two integrated cameras*. So, you'll know what you have – or haven't got – in stock for dinner.

A MIND OF ITS OWN:

The hyperFresh storage system, available across the Siemens' refrigeration range, ensures a constant storage climate, ensuring nutrients are kept at their very best for longer. Handy for those last-minute cheffing moments.

*Only on iQ500 KG36NHI32 model





martphones and refrigerators – by their very purpose – tend to have little in common. One is sleek, sophisticated and can fit in your pocket – the other, not so much. However, there are similarities. For example, not all kitchenware needs to serve only one purpose. So much so, in fact, that Siemens is continuing to push the boundaries of what's possible in the kitchen with its intelligent cooling range – a collection that is spearheaded by its latest iQ500 and iQ700 refrigerators. Statement pieces of design in themselves, the Siemens' appliances come armed with several functions – much like any smartphone worth its salt – that make any modern lifestyle a touch easier.

The natural starting point is the iQ500 refrigerator's Wi-Fi functionality. Offering total connectivity with the free *Home Connect* app – available for both iOS and Android users – it helps eliminate that all-too-familiar issue of forgetting what's in the fridge

The connected fridge is finally here. And it's a more powerful home tool than a device that reminds you that your milk is beginning to sour

and, crucially, if it's still fresh. Working in tandem with a set of integrated cameras within the refrigerator, the contents of the fridge can be viewed on a smartphone from anywhere with a 4G connection – a feature that, handily, means you'll never be caught short when it comes to food.

Similarly, Siemens is helping tackle unnecessary food waste. Remote controlling allows you to intuitively select and activate the ideal setting for refrigerator. And the iQ500 and iQ700 refrigerator's hyperFresh storage system is a dedicated section of the refrigerator – with advanced humidity control options – it is designed to keep fruit and vegetables fresher for longer. It also helps retain essential vitamins, nutrients and flavours (almost doubling the lifespan), meaning less time spent shopping for fresh produce and, crucially, less food wasted. Carnivores are served, too: the iQ500 and iQ700 refrigerator's hyperFresh 0°C drawer remains in a constant state of being 2-3° cooler than the rest of the area, meaning that meat and fish remains fresh for twice as long when compared to other appliances.

Of course, each feature of Siemens refrigerators – whether it's the integrated Wi-Fi, internal camera system or advanced humidity control – comes with you in mind and with a mission to make creating great dishes more convenient, while putting (and keeping) you at the forefront of kitchen technology.

SIEMENS / WIRED PARTNERSHIP



INTELLIGENT DESIGN

STEP UP TO THE NEXT LEVEL OF KITCHEN TECHNOLOGY WITH SIEMENS, WHERE EACH APPLIANCE PROMISES TO MAKE YOUR DOMESTIC LIFE EASIER AND SIGNIFICANTLY MORE FUTURE-PROOF

Sensibly, millions all over the world trust Siemens when it comes to delivering forward-thinking home appliance technology. When Werner von Siemens laid the foundations of what would become one of the world's most innovative creators of homeware, his motto of "progress serving people" became the key principle for the company. It still rings true today with the inimitable iQ700 range. Each piece in the range has a strikingly stylish design, whether alone or combined, even down to the settings. Notably, the Siemens

oven – with a large TFT touchDisplay and full-screen animation – enables food to be cooked in half the usual time with its varioSpeed function – a feature that champions combined heating technology. That means less cooking and waiting time, without compromising on quality.

Built-in coffee machines and warming drawers are part of the new range too, while the iQ700 dishwasher ensures glassware is gleaming and streak free. Your future kitchen never looked so good – or so necessary. siemens-home.co.uk

APD

BIOCHEMISTRY

LIFE HACKS THAT ACTUALLY MATTER

Disease is in the sights of gene reprogrammers. By Kat Arney

EARLY IN 2012, RODGER NOVAK TOOK a call from Emmanuelle Charpentier, co-discoverer of CRISPR-Cas9¹ – a DNA editing tool that has shot from the pages of academic journals to worldwide renown in four years. “She asked me what I thought of CRISPR but I didn’t understand the question,” he recalls. “I said, ‘What’s CRISPR?’” >

Charpentier outlined to him exciting results that were starting to come out of her lab, building on a paper she published back in 2011 in the journal *Nature*² looking at how bacteria use the CRISPR-Cas9 system to cut up DNA from invading viruses. Back then it had seemed more of an academic research tool for chopping up DNA, but it was becoming clear to her that there were much wider applications – including altering the human genome – and she needed advice on how best to exploit them.

Charpentier and Novak first met in the 90s when they were post-doctoral researchers together at Rockefeller University in New York. An effusive and affable German, Novak chose to forge a career in the pharmaceutical industry while the quieter and more academically minded Charpentier pursued her research, eventually ending up at Umeå University in Sweden, where she made her key discoveries. In his role as global head of infectious diseases at Sanofi's research and development labs in Chilly-Mazarin, France, Novak was the obvious person to call when Charpentier realised that her findings might have commercial value.

CRISPR-Cas9, usually known as CRISPR, is a two-part DNA-editing system that can be guided to almost anywhere in the genome of any organism. The CRISPR component itself is the biological equivalent of a satnav, comprising short stretches of RNA – the molecular “cousin” of DNA. These can be designed to match up with any DNA sequence and, once in place, CRISPR calls in Cas9, an enzyme that snips through the DNA at precisely the right spot. The resulting gap is then filled with any other piece of genetic material, repairing, removing or entirely replacing what was there before.

The power of the technique was illustrated in a study reported in the journal *Science* at the end of 2015, in which researchers used CRISPR to replace the faulty gene responsible for causing the fatal muscle-wasting disease Duchenne muscular dystrophy in mice. It wasn't exactly a cure – the treated mice still weren't as strong as fully healthy animals – but it was an important proof of principle. And given that 20,000 babies a year are born with the condition worldwide, it was a powerful statement of hope for families as well as the research community.

A few months after that initial phone call in 2012, Charpentier and her University of California Berkeley collaborator Jennifer Doudna published their breakthrough research paper in *Science*, describing how CRISPR works and exploring its potential for precision genome editing. Based on his conversations with Charpentier ahead of publication – and the excitement in the research and industrial communities as word spread – Novak got in touch with VC and entrepreneur Shaun Foy to see if there was any commercial mileage in these gene-hacking tools. The answer was unequivocal. “[Shaun] checked it out and about four weeks later he called me saying, ‘Listen, you have to leave your job – we’re going to build a company,’” says Novak.

That company became CRISPR Therapeutics, originally founded in Switzerland as Inception Genomics in 2013 by Charpentier, Foy and Novak, who's now CEO. Starting with \$25 million (£17m) in seed funding, Novak and his team are now sitting on more than half a billion dollars, much of it thanks to recent deals with pharma giants Vertex and Bayer. Signed in October 2015, the deal with Vertex released \$105 million upfront, with more to come if CRISPR Therapeutics hits key targets in the development of treatments for blood disorders and cystic fibrosis. And in December 2015, the deal with Bayer brought in \$300 million for research and development of therapies for a range of ailments including hereditary blindness³ and heart defects.

‘You have to leave your job – we’re going to build a company’



There's still a long way to go before CRISPR-based treatments are ready for testing. The tech works well on cells grown in the lab, and is showing promise in animal models of some human diseases, but correcting DNA errors in patients is a bigger challenge. At a new research facility in Cambridge, Massachusetts, the firm's scientists are starting to tackle the problem of delivering CRISPR's precision scissors – or, at the very least, cells that have had their genetic faults edited out using the technique – to the places in the body where they're needed.

Novak and his team have set their sights on delivering CRISPR directly into organs in situ. The eye is a good candidate: Pennsylvania-based Spark Therapeutics has already used viruses to deliver replacement genes into the eyeballs. However, the effects don't last, so CRISPR-based approaches could take things a step further by permanently repairing the genetic fault causing the problem.

“One of the interesting organs we'd like to target is the liver,” Novak says. “That's certainly the way to go. We're doing this and we're doing other things, but it's not a problem keeping our teams busy here because it's a tremendous amount of work.”

Other companies – including Editas Medicine (co-founded by the Massachusetts-based Broad Institute's Feng Zhang, credited as a co-discoverer of CRISPR) and Intellia Therapeutics, co-founded by Charpentier's collaborator Jennifer Doudna at University of California, Berkeley (UCB) – are also staking out claims to this territory, sparking a fierce legal battle between the two host institutions.

The patent rights are assigned to Zhang and the Broad, which licenses it to Editas, but this is being challenged by UCB. If UCB's successful, the rights could transfer to Doudna's team. Editas would then need to negotiate a licence from her at unknown cost. Despite this, Editas floated on NASDAQ in January 2016, raising more than \$94 million.

“In academia, when there are great discoveries there are always people who claim something they shouldn't,” Novak says. “There are US institutions which aggressively rewrite history. And that's something we as a company feel a responsibility for – to take care of [Charpentier] because we benefit from the fact she's our founder and the person who enabled the field.” Her key experiments were in Sweden, where the law recognises “professor's privilege”: the person who made a discovery, rather than the institution, owns the IP. “We shouldn't forget that since [she] is one of the key inventors of this patent, she's in a very special situation as the owner of this IP,” Novak explains. “I think it's fair to say without her work we wouldn't have any CRISPR companies. We wouldn't have anything.”

1. Doudna JA and Charpentier E, 2014. “The new frontier of genome engineering with CRISPR-Cas9,” *Science* 346:1258096

2. Jinek M et al, 2014. “A programmable dual-RNA-guided DNA endonuclease in adaptive bacterial immunity,” *Science*. 337:816-213. [researchgate.net/publication/275517326](https://www.researchgate.net/publication/275517326)

3. Ledford H, 2015. “Success against blindness encourages gene therapy researchers,” *Nature* 526, 487-488

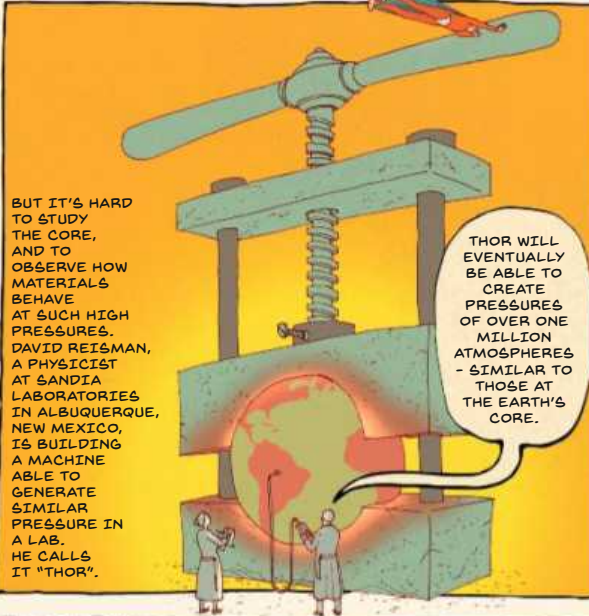
JOURNEY TO THE CENTRE OF THE EARTH

Each month we illustrate today's pioneering projects.

This issue: how David Reisman of Sandia Laboratories built "Thor" to recreate pressures similar to those one would encounter in the Earth's core



OUR PLANET'S INNER CORE IS AN IRON AND NICKEL SPHERE, 1,220KM IN RADIUS. ITS MOVEMENTS INFLUENCE EARTH'S MAGNETIC FIELD.



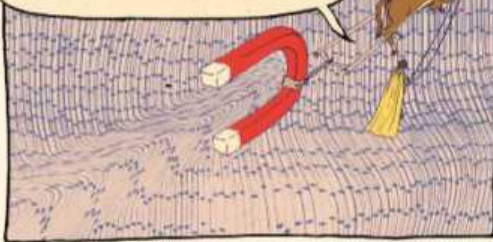
BUT IT'S HARD TO STUDY THE CORE, AND TO OBSERVE HOW MATERIALS BEHAVE AT SUCH HIGH PRESSURES. DAVID REISMAN, A PHYSICIST AT SANDIA LABORATORIES IN ALBUQUERQUE, NEW MEXICO, IS BUILDING A MACHINE ABLE TO GENERATE SIMILAR PRESSURE IN A LAB. HE CALLS IT "THOR".

THOR WILL EVENTUALLY BE ABLE TO CREATE PRESSURES OF OVER ONE MILLION ATMOSPHERES - SIMILAR TO THOSE AT THE EARTH'S CORE.



THOR WILL USE A SUDDEN DISCHARGE OF ELECTRICAL CURRENT TO TRIGGER AN INCREASE IN PRESSURE AND TEMPERATURE.

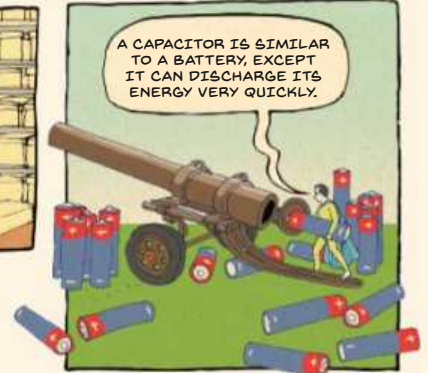
WHEN YOU WORK WITH LARGE AMOUNTS OF CURRENT AND HIGH VOLTAGE, THE ELECTRICITY GENERATES A GIGANTIC MAGNETIC FIELD. THIS CAN THEN BE HARNESSSED TO CREATE COMPRESSION.



THOR'S ENERGY COMES FROM SHOEBOX-SIZED POWER STORAGE "BRICKS". EACH ONE HOLDS TWO CAPACITORS THAT CAN PROCESS 100KV.



A CAPACITOR IS SIMILAR TO A BATTERY, EXCEPT IT CAN DISCHARGE ITS ENERGY VERY QUICKLY.



WHEN MATERIALS ARE BOMBARDED WITH X-RAYS, THE RAYS DIFFRACT THROUGH THEM. THESE DIFFRACTION PATTERNS REVEAL THE STRUCTURE.



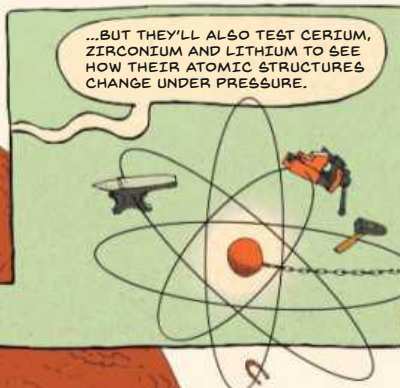
SANDIA'S SCIENTISTS CAN COMBINE THOR WITH X-RAYS TO STUDY THE WAYS CERTAIN MATERIALS BEHAVE AT THE EARTH'S CORE.



THE ENERGY IS CONCENTRATED DOWN TO THE MATERIAL, CREATING A PULSE THAT EXERTS EARTH-CORE LEVEL AMOUNTS OF PRESSURE.

CHARGED BRICKS ARE CONNECTED TO A RING-LIKE STRUCTURE. THE STORED ENERGY IS DISCHARGED IN ABOUT 100 NANSECONDS.

...BUT THEY'LL ALSO TEST CERIUM, ZIRCONIUM AND LITHIUM TO SEE HOW THEIR ATOMIC STRUCTURES CHANGE UNDER PRESSURE.



THE FIRST MATERIAL TESTED WILL BE IRON, BECAUSE IT'S THE MAIN SUBSTANCE AT THE EARTH'S CENTRE...

THOR CAN BE USED TO STUDY THE PROPERTIES OF MATERIALS INSIDE THE CORES OF DISTANT EXOPLANETS. THAT WOULD TELL US ABOUT HOW THEY CAME TO BE, AND PERHAPS WHAT WE MIGHT FIND IF WE WENT THERE.



Q & A

SHINE A LIGHT ON THE WORKING BRAIN

Gero Miesenböck explains how light-responsive cells illuminated the field of neuroscience

IN 1999, NEUROSCIENTIST GERO Miesenböck dreamed of using light to expose the brain's inner workings. Two years later, he invented optogenetics, a technique that fulfils this goal: by genetically engineering cells to contain proteins that make them light-responsive, Miesenböck found he could shine light at the brain and trigger electrical activity in those cells. This technique gave scientists the tools to activate and control specific cell populations in the brain, for the first time. For example, Miesenböck, who directs the Centre for Neural Circuits and Behaviour at the University of Oxford, first used optogenetics to activate courtship responses in fruit flies, and even make headless flies take flight – ground-breaking experiments that allowed him to examine, in unprecedented detail, how neurons drive behaviour. WIRED talks to Miesenböck, a speaker at WIRED Health 2016, about how optogenetics changed neuroscience, and why intervention holds the key to scientific understanding.

WIRED: Combining genetics with light – how did that idea come to you?

Gero Miesenböck: There was almost a “eureka” moment. As is often the case, you tend to have your best ideas when you're not trying to have them: suddenly I had this idea – which I must have been incubating for a long time,

because I was thinking about manipulating neurons in the brain genetically to emit light so I could visualise their activity. Suddenly I thought, “What if we just turn the thing upside down, and instead of reading activity, write activity using light and genetics?” That was the real breakthrough idea, and then of course came the big challenge of having to make it work.

Actively “writing” or “creating” brain activity is the principal idea behind optogenetics – how does it work?

Brains are composed of many different kinds of nerve cells, and they are genetically distinct from one another. To deconstruct how the brain works we need to pinpoint the roles these individual classes of cells play in processing information. Optogenetics uses the genetic signatures that define individual cell types to address them selectively in the intact brain – that's the “genetics” component. The “opto” component is to use these genetic signatures to place light-sensitive molecules that are encoded in DNA within these cells. Our brains normally run on electricity, and optogenetics uses those light-sensitive molecules to generate electrical impulses only in the cells that have been genetically targeted to respond to light. Then, it's possible to “talk” to these cells using flashes of light.

In order to truly understand the brain, you believe we have to intervene. Why is intervention so important?

There was a mathematician called Richard Bellman who said that there's

a natural progression in all scientific fields, that people initially start out just observing nature, but as they learn more and more about its underlying forces, scientists change from observers to doers. Being able to do, to control, is important not just for technological reasons; I think it's also the most powerful way to understand how something really works. This is how you can test your hypothesis, how you can find out whether you are actually right or wrong in your understanding.

Can you give an example?

If I hypothesise that certain cells have a powerful control over sleep, then my prediction is that if I switch these cells on [using optogenetics on a fruit fly], the fly will fall asleep¹. If the experiment doesn't turn out that way then I know my idea is wrong. You can't get the same powerful conclusion by observation. Rather than observation, optogenetics is about connection and control. I think what it enabled in neuroscience – why it has been so impactful, even transformative, perhaps – is that it has moved the field from passive observation to active intervention.

Optogenetics was first applied to brains, but it has since spread...

Yes of course. The heart is one. People have altered the rhythm of a beating heart by using optogenetic



interventions. Somebody emailed me a paper a while ago showing that sperm can be controlled optogenetically. And then of course one can interfere not only with electrical but also various aspects of biochemical signalling. One can switch genes on and off, one can turn on and off the chemical messages through which cells communicate. The seed of the idea has now spread to many, many different domains throughout biology.

You're currently using optogenetics to study sleep in fruit flies. Why?

There's a mechanism in the brain that somehow keeps track of how long you've been awake, and puts us to sleep when we have exceeded our limit. Obviously, we don't know what that mechanism responds to. But if we could understand what that is, then I think we'd really break the problem open. We are working on this issue in flies at the moment, and we use optogenetics to control various groups of cells in the brain that either instantly put flies to sleep or wake them up again². Then we see how these cell groups normally talk to each other, which signals they send and how they're generated. Being able to understand what normally controls the function of these cells will probably allow us to make significant inroads into discovering the vital but still completely mysterious biological function of sleep.

Is optogenetics driving any interventions that benefit humans right now?

One example is the visual restoration in the retina. Many people have degeneration of the photoreceptors in their retinas, and optogenetics will provide a simple way of putting some light sensitivity back into them. There are also attempts to develop optogenetic deep-brain stimulation – for example, for treating Parkinson's disease.

What's the future of this technique?

When post-doc candidates write to me and say, "I would like to join your lab to work on optogenetics," I'm always a little disappointed: if you focus on a technology, it will be superseded or outdated or replaced. Or, if it works it's trivial. The great sensation in biology 30 years ago was the polymerase chain reaction. But once it worked, it worked. I think the biological problem must take centre stage, always. **Emma Bryce**

1. "In early experiments we illuminated the whole fly. Now we can control the optical driving signals with much greater precision in space and time."

2. Miesenboeck is investigating how quickly fruit flies make decisions. "They think a little hard and longer if we give them a difficult problem to solve."



IMAGE OF THE MONTH

Crawling through rubble

Using the robust cockroach as inspiration, a team at Berkeley has devised a miniature first-responder robot

This cockroach-inspired robot can compress to half its size and race through narrow cracks, just like its inspiration. Called CRAM (compressible robot with articulated mechanisms) and designed by biologists at the University of California, Berkeley, the scurrying device could help locate disaster victims in hard-to-reach places, such as collapsed buildings. **EB**

NEUROSCIENCE

Yvette van Kooyk

is making a cancer vaccine at the nano scale. "By using nanotechnology to deliver vaccines into the body, we can create more powerful cancer treatments," says van Kooyk, an immunologist at the VU University Medical Center in Amsterdam. She's building nanovaccines out of glycans, sugar molecules that naturally bind to receptors

on immune cells in the body.

"The glycan is used for specifically targeting the cells that you need," van Kooyk explains. She exploits this trait by attaching the glycans to cancer-fighting antigens, relying on the sugar molecules to transport those antigens directly into the target immune cells, where they trigger an immune response, telling the body to attack



its cancerous cells.

Because the vaccine can target immune cells so precisely, "you don't lose your vaccine to other cells," van Kooyk says. That enables the vaccine to launch a targeted and particularly powerful immune response that may be capable of destroying tumours.

Now, she is tailoring the nanovaccine to

work on diseases

including melanoma, pancreatic cancer and glioblastoma, a type of brain tumour. The ultimate goal is to give patients lifelong immunity from certain cancers so that they don't develop again, she says. In three years, she estimates, they will start trialling the vaccines on humans. **EB**

NANOVACCINES AGAINST CANCER

Bio-inspired materials at the nano scale enable personalised immunity

NEXT ISSUE

THE WIRED 100

GOES GLOBAL

WHO'S IN IT?

WIRED
ON SALE AUG 4

FEATURES



ILLUSTRATION: ISTVÁN SZÜGYICZKY. CREATED IN PHOTOSHOP AS AN EXPLORATION OF REFLECTIONS AND SURFACES UNDER TENSION

"When we created Team Sky, we sat down with a blank sheet of paper and said, 'How shall we do it?'" Dave Brailsford, p124



**THE SCIENCE
—BEHIND—
TEAM SKY**

**WHAT IT
TAKES TO**

WIN®



W

hen Chris Froome is racing, he imagines that he has a bag of coins to spend. Every time he wastes energy, he needs to pay. He pays whenever he's pedalling against the wind. He pays when he moves up the peloton during a climb instead of waiting for a flat road where he can get maximum drag off the riders around him. He even pays for trivial manoeuvres such as collecting bidons of water from the support car that follows riders during a race. He pays because all these moments imply an acceleration, an intensification of effort that puts Froome in the red.

In physiological terms, the moment that requires payment is called the threshold: the point beyond which you cannot ride comfortably for a long period of time. At any given stage of a race, Froome will try to spend as little time over that threshold as possible, even if that means losing his position within the group. Froome is attuned to it. As he crosses that threshold, he starts feeling his body screaming at him, shouting for oxygen, telling him to slow down. He starts breathing faster as his muscles demand more oxygen.

Then comes the pain. When it comes, he embraces it, knowing that it's highly likely that his rivals are in even more discomfort. He might look around the peloton checking for symptoms in the riders' body language. Alberto Contador, the Spaniard from team Tinkoff and winner of all three Grand Tours – Tour de France, Giro d'Italia and Vuelta a España – hides it well, grimacing for just a second. Nairo Quintana, from Colombia, sits very still on the bike, his face expressionless. Froome, on the other hand, is perhaps the most obvious in his suffering. Elbows out, head down, ungraceful. But pain is sometimes a signal for Froome to make his move, especially if he has made his savings, carefully

considering the energy that went into every single pedal stroke. He knows that when it comes to the final climb at a key stage of a Grand Tour, the rider with the most coins left is the one most likely to win.

That's what happened during stage ten of the 2015 Tour de France. It was the first mountain of the Tour, a hilly 166km stretch of road between Tarbes and La Pierre-Saint-Martin in the Pyrenees that finished at an elevation of 1,610m after 15.3km of climbing. Froome, who weighed 67.5kg at the time, averaged a power of 414

Watts during that climb. With 6.5km to go, he accelerated for 24 seconds, averaging 556 Watts. It was a devastating attack that left Quintana, his nearest opponent, for dust, and a performance so spectacular that journalists questioned its provenance. In the subsequent press conference, Tim Kerrison, Froome's coach, told reporters that it was not unexpected considering some of the numbers the rider had achieved in the past. For instance, Froome's average power over 60 minutes, including the run-in to the climb, was 366 Watts, and Kerrison



pointed out that Froome had exceeded that level on 15 occasions since 2011, in racing and training. Furthermore, his heart rate readings indicated that he had reached the stage feeling fresh and in good physical condition. In other words, he had saved most of his coins. "It's great when you manage to save as much as possible and you're ready for the last climb," Froome says. "You know you're going to lay it all out there and just go for it."

Of course, Froome's extraordinary performance wasn't just a direct result of his natural ability, but a by-product

of his training. Kerrison was able to cite exactly how many times Froome had exceeded the power output number that he registered at Pierre-Saint-Martin; after all, he's been tracking data from every single pedal stroke his riders take, both in racing and training, for more than four years. That data is the foundation for the comprehensive and detailed training programme that all Team Sky riders undertake. "I work on the basis that everything we do is probably wrong," Kerrison says. "There are sure to be better ways of doing things. Pretty much every day

we do things differently. The riders understand why we do things the way we do. They can always see how it relates to the overall picture."

Chris Froome, 31, has blue eyes and close-cropped hair. His body shape is ectomorphic, with long, lean limbs. His demeanour is quiet but polite and inclusive. When we sit down to talk in the living room at Team Sky's house in Nice, he asks for permission before reclining on the sofa and stretching out. He either looks straight at the ceiling or across his shoulder directly at WIRED when making a particularly salient point, such as the moment he began to have confidence in himself as a rider and started being smarter about his racing style. He used to be careless with his energy. He was impulsive. Or sometimes team tactics dictated he had to attack at the beginning of the stage and, by the time the race reached the key moment of a climb, he would have nothing left to give.

It's not that Froome lacked the natural capacity; he always knew he had, as he puts it, a "big engine". He just didn't know how to use it. When he was tested in a physiology laboratory on July 25, 2007, in Lausanne, Switzerland, he was told that the maximum rate at which he could consume oxygen – a physiological parameter that goes by the name of $\text{VO}_{2\text{max}}$ – was 80.2ml of oxygen per minute per kilo of body weight, and his threshold power sat at a 420W. These were undoubtedly the numbers of a potential Tour de France champion.

When Froome joined Team Sky in 2010 from Barloworld, he would produce incredible numbers in training, frequently much higher than his teammates, even though unbeknown to him at the time his body was ridden with parasitic flatworms (a disease called bilharzia, for which he was eventually treated). And yet, he was inconsistent when competing. By the 2011 season, Team Sky's performance director Dave Brailsford was considering dropping him from the squad. His standing in the team was such that the pre-race plan for the 2011 Vuelta a España said: "[Teammates] Xabier [Zandio], Morris [Possoni] and Froome will do their best to survive as long as possible and will fetch bottles, etc." He finished that Vuelta in second place, ahead of Bradley Wiggins, Team Sky's leading rider at the time. That, he says, was the big turning point in his cycling career. A year later, when Wiggins won the Tour de France, Froome finished second.



Above: Froome on a time trial exercise in hills near Nice, with trainer Tim Kerrison following

"I began to understand that I belonged with the best climbers," Froome says. "I wasn't struggling the way I thought I would be." He gained confidence and learned how to use his internal engine. When he repeated the physiological test in August 2015, his values hadn't shifted much – VO_2max was now 84.6 and his threshold power 419W – the difference could be accounted for by his weight loss of 5.7kg. These were the numbers of a two-time Tour de France winner.

In 2009, when Dave Brailsford announced the creation of Team Sky, Britain's only professional race cycling team, the goal was to win the Tour de France within five years – a bold target considering that Britain never had much tradition in road cycling.

Winning the Tour de France had been a dream Brailsford had harboured since he was a teenager. He was brought up in a mining village in North Wales, and in 1983, aged 19, he decided to try competing in the Tour de France. He stuck his bike inside a cardboard box and bought a one-way ticket to France. "I grant you, I was a bit naive and didn't really appreciate the magnitude of the challenge," Brailsford says. "I went to the end of a bike race, when everybody arrived with their cars and everything. I looked around for the nicest kits, went up to them with my bike in its box and said, 'Hi, can I race for your team?' And they were all like, 'What?'"

Brailsford ended up spending four years in Saint-Étienne, failing to race at the Tour de France, failing even to become a professional. He eventually returned to the UK and completed a degree in sports psychology followed by an MBA at the University of Sheffield Management School.

In 1997, he was hired by British Cycling as an operations director to look over its business side. The programme was run by Peter Keen, a respected sport scientist known for his

meticulous and innovative approach to coaching. As performance director, Keen was taking steps to modernise an underfunded, understaffed team with no infrastructure for proper training. In 1998, after the announcement of Lottery funding for sports in the UK, Keen put together an ambitious and detailed plan entitled the World Class Performance Programme. He stated his vision clearly: to make the UK the world's top cycling nation by 2012. Few people believed it was possible.

At the core of his plan was the application of a scientific and rational method to the art of cycling performance. It was a clear break from a past dominated by a mindset rooted in tradition, low self-belief and an unwillingness to explore new technology. British Cycling hired performance analysts, physiologists and biomechanists. "We had a lack of history in terms of cycling. There were no professional cycling coaches, so we hired young smart sport-science graduates," Brailsford says. "You might say that with hindsight that was a great decision. We were lucky to have this group of guys who came up with all kinds of weird and wonderful ideas. Nobody ever said that something was not going to work."

Perhaps the most significant step early on was the acquisition of a set of power meters for the bikes, which allowed the measurement of the energy per second the cyclists could produce: their power output, in other words. Whereas before, cyclists had to rely on monitoring heart rate, speed and perceived exertion – all parameters that were easily influenced by environmental factors and had nothing to do with performance – power output was an objective measure and was the perfect tool for performance-based training. It allowed track cycling to become a data-driven sport. The power meters, along with other technologies like video analysis and aerodynamic testing, allowed British Cycling performance analysts to create a systematic analysis of the numbers – lap times, cadences, power outputs, drag factors – that their riders could produce. They would also do an in-depth analysis of the numbers that were needed to win races, a process they called analysis of the demands of the event. "We would go to the nth degree in terms of truly understanding what winning looked like," Brailsford says. "This allowed us to create a document called 'What It'll Take to Win'. We spent more time than any other team in the world doing that particular work."

By the time Keen left in 2003, Brailsford had inherited a British Cycling team that had already accrued significant success in the Olympics. Alongside its emphasis on sport science, Brailsford introduced an organisational principle called "Performance by the aggregation of marginal gains". As a philosophy, it was akin to a widely known business concept known as Kaizen, popularised by Toyota, which requires the implementation of a culture of continuous improvement. In fact, the name "marginal" came to Brailsford as he was reviewing some studies he had done during his MBA on marginal costing. In cycling terms, it meant breaking down everything that goes into riding a bike and looking for the one per cent shifts that would make a difference. It seemed obvious to Brailsford that going after big ideas was difficult to do on a daily basis, but small gains, which were often overlooked, could be regularly aggregated to create meaningful change.

"Marginal gains came out of the magnitude of change required, in terms of where we were and where we wanted to get to," Brailsford says. "And then, equally, I know this sounds a bit contradictory, the margins of victory. You could win a race by one-tenth of a second. And you're thinking, 'OK, if we could win a race by one-tenth of a second, all these little things over here could equate to one-tenth of a second. So, why won't we do them?'"

After the Beijing Games in 2008, with Brailsford still at the helm, British Cycling had become one of the most extraordinary success stories in the history of sport. Atlanta 1996: two medals, 12th place; Sydney 2000, four medals; Athens 2004, four medals and third place; Beijing 2008: 14 medals and first place. This was the sort of epic British success story that Brailsford wanted to replicate in road cycling with Team Sky.

"When we created Team Sky, we sat down with a blank sheet of paper and said: 'Right, we're going to create a professional cycling team. How should we do it?'" Brailsford recalls. "We took what we'd learned and tried and tested over the years in British Cycling and put it all on the page."

During its first year of operation, Team Sky became well known for its relentless application of marginal gains, in stark contrast with the traditional professional teams at the time. Team Sky's jerseys were designed with a thin blue line that ran down the spine to symbolise the



Mechanic Matteo Cornacchione prepares a race bike for stage four of the Giro del Trentino in Malè, Italy

HOW TEAM SKY LEARNED TO WIN

- 1 / **PERFORMANCE STRATEGY**
Team Sky uses performance analysts to work out the physical and mental demands of an event such as the Tour de France. It then works backwards from that analysis to understand what it will take to win it.
- 2 / **HUMAN MIND AND CULTURE**
Team principal Dave Brailsford claims he spends 90 per cent of his time thinking about people and group dynamics. His biggest influence is psychiatrist Steve Peters, who has worked with Brailsford since 2002.
- 3 / **AGGREGATION OF MARGINAL GAINS**
In other words, continuous improvement. At British Cycling, the team once considered shaving 10mm from a rider's collarbone to make him more aerodynamic. The team doctor didn't allow it.

margin between victory and defeat, made from a special black fabric that reflected heat. It hired Honda's Formula 1 logistics manager Gwilym Mason-Evans to gut the inside of the team bus and completely redesign it. It employed a team of carers who would go to the hotels where the riders would be staying to remove mattresses, vacuum the beds underneath and replace them with mattresses and pillows made of elastic foam that had been individually customised so that the riders could maintain the same posture every night. It taught its riders how to wash their hands properly, made them carry hand gels at all times and forbade handshakes to prevent the spreading of illnesses during competition. It had bike-fitting sessions using 3D motion-capture technology in Valencia, Spain. It ordered the manufacture of a Perspex cocoon in which the team could warm up away from crowds and the media.

The sporting results, however, were disappointing. Bradley Wiggins had finished fourth at the previous Tour de France riding for Garmin-Slipstream. Now Team Sky's main contender, he finished the next in 24th place. "I think we'd come into the sport thinking

that we knew a lot, we'd won all these Olympic medals and it was kind of going to be easy," admits Fran Millar, Team Sky's director of business operations and head of winning behaviours. "Bradley was having ice baths and drinking cherry juice and all sorts of stuff, but he just wasn't fit enough. Dave said that we had concentrated too much on the peas, and not on the steak."

Prior to the start of the 2010 season, Brailsford hired Australian performance analyst Tim Kerrison. He was a former rower with extensive experience of coaching and as a sport scientist for swimming. He had been exclusively involved in swimming since 1998, working with a group of female sprinters who went on to have a very successful 2004 Olympics in Athens. "There was this ingrained culture of swimming which was very conducive to developing good aerobic distance-based, endurance-based athletes, but not sprinters," Kerrison says. "We recognised if we do what we've always done, we'll get what we've always got. That needed to change. Let's forget everything we know about swimming and the way

Frøome undertakes an aerobic profiling session at the GSK Human Performance Lab with senior scientist Phill Bell



everyone trains and think from first principles. What do we know not just about swimming, but other sports and physiology and training science?"

Most training programmes at the time were based around the idea of periodisation. "It's essentially the way the emphasis of training shifts over time," Kerrison says. "This can include a greater emphasis on workload or recovery, or a shift in the emphasis of the type of training within a training block." Traditionally, periodisation involved an initial training period which was predominantly focused on endurance and aerobic capacity, with more intense anaerobic workouts that included speed and power training added later in the year as a competition approached.

"We turned the conventional periodisation idea around," Kerrison says. "It made more sense. One of the foundations of sports training is specificity, which means that everything you do in training has to be related, to some degree, to what you need to do in competition. So we began working on the team's anaerobic systems from the very beginning, developing their strength, speed and power. Only later did we lay on more aerobic training."

Kerrison had been working as a sports scientist for the British swimming team since 2005 when Brailsford contacted him. At that point, he had already received a job offer from England Cricket that he was about to sign, and although Kerrison had never worked with cyclists, Brailsford convinced him to join Team Sky. "I grew up thinking that the Tour was one of the ultimate sporting challenges," Kerrison says. "I still think it is. I can't think of many things more challenging and special to me than winning the Tour de France. So it's a very meaningful goal. How realistic it was, I wasn't sure."

When Kerrison joined Team Sky in late 2009, Brailsford told him that they were not expecting anything from him until November 2010. His mission was just to follow the team around as they competed for their first Tour de France. They hired a camper van, nicknamed Black Betty, which Kerrison shared with fellow performance analyst Matt Parker, then Team Sky's head of marginal gains. Kerrison spent this time taking a lot of notes and talking little. "He travelled round with the team working with our power data and not really visibly much else. Everyone was just, 'Who is this weird Australian who lives in a camper van?'" Fran Millar recalls.



Team Sky's head of athlete performance Tim Kerrison:
"Winning the Tour de France is a very meaningful goal" —

A

t the end of 2010, after the first season of racing, Brailsford told Kerrison, who had been in cycling for about a year, that he was going to coach Bradley Wiggins and that he had to formulate a plan to win the Tour de France. "I did what I had done with the sprint swimmers in Australia: go back to the very first principles," Kerrison says. "It was a huge benefit to not have my judgment clouded by all the other stuff I didn't know and just quickly work out exactly what I needed to know. We needed to forget

about the culture, and forget about all the bullshit and the peripherals."

One of the first things Kerrison did was to try and find out exactly what it would take to win the Tour. After all, much of the success of British Cycling had been built around a methodical analysis of an event's demands and knowing what it took to win. "Riders used power and trained for power to a certain extent," Brailsford says. "They would download their training information into the system and get nothing back, so they stopped doing it. Kerrison changed all that. Our compliance rates, in terms of riders, when they're at home downloading the data, went through the roof, because they all started seeing how it affected their training plans."

Kerrison adopted a database system called Training Peaks in which the athletes could download the data so that he could study it. Using this data, Kerrison did a power curve analysis for each athlete that showed, for a given duration – from one second to three hours – how much power a rider could sustain. ("It's an ongoing thing now," Kerrison says. "Every day we have a new current power curve for the riders. Over time we have built up

a knowledge of what this means and how to interpret it.”) Then, based on the data available for previous Tour de France winners and on extrapolations, he estimated the power curve corresponding to what it would take to win the Tour de France. “Those were the demands of the event,” Brailsford says. “We compared the capacity athletes had against what was needed to win and trained the athletes against that.”

Kerrison also understood that Team Sky would need good climbers that could perform at altitude and at high temperatures. “A lot of decisive moments in the Grand Tours are performed at well over 1,000 metres, sometimes as high as 2,500 metres,” Kerrison says. “So if you’re not able to perform at that level, then you’re screwed, basically.”

The body adapts to training at altitude, mostly through respiratory adaptations, recalibrating to different levels of oxygen. To address this, Kerrison scouted Europe for high-altitude camp locations, eventually deciding on Tenerife. “Britain doesn’t have high mountains and heat so our cyclists weren’t used to it,” Kerrison says. “I did start to question if we were going to be able to compete with guys who spent their whole lives growing up riding in the mountains at altitude in the heat.” Still, Kerrison wondered how quickly the athletes would be able to adapt, so at the start of their first Tenerife camp, they tested their athletes’ efforts at altitude and at sea level. On day one, the average difference in the athletes’ threshold between sea level and 2,100 metres was about 70 Watts – a significant number. By day three, it was 35 Watts. After two weeks there was no difference. The riders had acclimatised.

When Kerrison presented his plan to win the Tour de France, he essentially said that they had to forget about the details until they got the basics right. For Wiggins, those basics were conditioning, weight management, time trialling and performing at altitude and in the heat. “We were so caught up with all the bells and whistles, the marginal gains and all the clever stuff,” Brailsford says. “We delivered all of that in year one and it didn’t work. We didn’t get our basics right. That was a big learning for me and Kerrison was a bit part of that. We decided on a new mantra that winter: ‘Doing the simple things better than anybody else.’” That year, Bradley Wiggins crashed out on an early stage of the Tour, breaking his collarbone. In 2012, however, he became the first British rider to win it.

O

One afternoon in April 2016, Kerrison

is at the wheel of one of Team Sky’s Ford Mondeos following Froome as he pedals a few metres ahead in the hills around Nice, in the south of France. He had already completed most of this training plan for the day: two flat efforts on the time trial bike – 15 minutes and 12 minutes – with about five minutes of recovery in between. Then he took part in a 20-minute climbing effort on the time trial bike before switching to a road bike and was now on his final effort: 12 minutes of “spiked efforts” building up to four minutes of threshold. “Froome’s anaerobic threshold is on around 450 Watts, but he rarely does anything at a constant pace,” Kerrison explains. “He might do one minute about 30 Watts over threshold and then three minutes with ten Watts under threshold. Overall, the effort over that period of time would be at threshold.”

This goes back to Kerrison’s idea of specificity. While sometimes the pace is constant at a race, other times it is very dynamic, with pace changing all the time. That’s what Froome is training for. Of course, on a more fundamental level, what Kerrison is manipulating in his mind is a more complicated set of equations describing the various cause-effect relationships between a training load and a physiological adaptation.

Consider the interplay between the distinct aerobic and anaerobic motors of an athlete. In simple terms, below the physiological landmark of the lactate threshold, the body is able to clear lactate as fast as it is produced. Above that threshold, it starts accumulating.

“People think developing the anaerobic system is a bad thing because it produces lactate and lactate is bad,” Kerrison says. “It’s only bad if you can’t remove it. Otherwise, it gives you power. When I was in Australia we had some distance swimmers who, no

matter how hard we pushed them, just didn’t produce any lactate. I’m not sure whether that was because they weren’t producing any or because they were efficient at removing it. We found out when we first measured Chris that it was the same. He would do a maximum effort and when we measured lactate there was nothing. Based on what I knew from swimming, I knew this was really promising. He was producing incredible power and whatever lactate he was producing he was able to remove. That indicated that we needed to increase his anaerobic capacity – his ability to produce lactate – because he had an ability to remove it.”

Kerrison then adds another layer to the consideration of Froome’s physiology: the nutritional he uses for this aerobic effort. This fuel is a mixture of carbohydrates and fats, which are metabolised in different proportions





Sports director Dario Cioni briefs Team Sky riders before stage three of the Giro del Trentino

depending on the intensity of the effort. The more intense the effort, the more carbs are required. But to Kerrison, even the way the body fuels can be trained and adapted, shifting it towards a type of metabolism that specifically benefits a rider racing the Tour de France. “We restrict carbs in training and this shifts the metabolism,” Kerrison says. “It drives an adaptation that makes the body become more efficient at using fat as fuel. So up to a certain intensity, say 200 Watts, Froome will predominantly be using fat as fuel. A significant portion of a typical five-hour stage is ridden at a relatively low intensity, meaning he’ll be burning mostly fat, saving the carb stores for the more intense stages of the stage where it’s needed the most – for example, the final mountain climb.”

According to Kerrison, the interaction between those three types of metabolisms – carbohydrate-fuelled aerobic, fat-fuelled aerobic and anaerobic – is the foundation of Froome’s training plan. When we return to Team Sky’s house, Kerrison shows WIRED a five-page checklist that he keeps for each of his riders. It includes items such as power curve analysis, demands of the events, fat-carb metabolism, heat and altitude. There are 74 factors, qualitative and quantitative, that encapsulate Kerrison’s understanding of what it takes to win. It’s the blueprint of what it takes to become a Tour de France winner, a title that Froome is defending this year after victory in 2015. He won it pretty much the same way as he had in 2013: by riding the first mountain

stage very aggressively and earning a substantial advantage early in the race. That strategy caught everyone off guard. It wasn’t part of Team Sky’s plans; it was a decision that Froome made a couple of weeks before the start of the Tour and even Kerrison wasn’t sure it was the best way to race.

Indeed, by the penultimate stage, Froome was struggling physically, exacerbated by a chest infection. Quintana, second in the general classification and 3’10” behind the leader, attacked relentlessly. “It was one of the days I had to fight the hardest to keep the yellow jersey,” Froome recalls. “The pain was severe, but I knew that once I got to the finish line it would be done.”

João Medeiros is WIRED’s science editor



PEAK OUTPUT

Sport science and technology are helping athletes – professional and amateur – to optimise their physical output. WIRED presents 15 innovations that can push human performance to the upper limits

By Jamie Millar

Photography: Shamil Tanna
& Christopher Hoare
Illustration: Janne Iivonen

TAEKWONDO SENSORS THAT BEAT HUMAN JUDGES

During the 2008 Beijing Olympics, referees missed a high kick by British athlete Sarah Stevenson that should have won her the fight. She was later reinstated to the competition, but the incident showed that the Korean martial art could be prone to human error. To remedy this, during the 2009 World Cup Taekwondo Team Championships in Baku, combatants wore magnetic socks and body protectors containing electronic sensors. For the Rio 2016 Olympics, competitors' headgear will be hooked up, and they will be able to request video replays. "It takes less power to register on the head protector than the torso," says Jinbang Yang, director general of the World Taekwondo Federation. "Athletes can focus on accuracy rather than force." With scoring weighted to reward roundhouses to the face, the fights should be fairer, more exciting and safer. worldtaekwondo.federation.net



Taekwondo fighters Feyi Pearce (left) and Tony Stephenson at the National Taekwondo Centre in Manchester

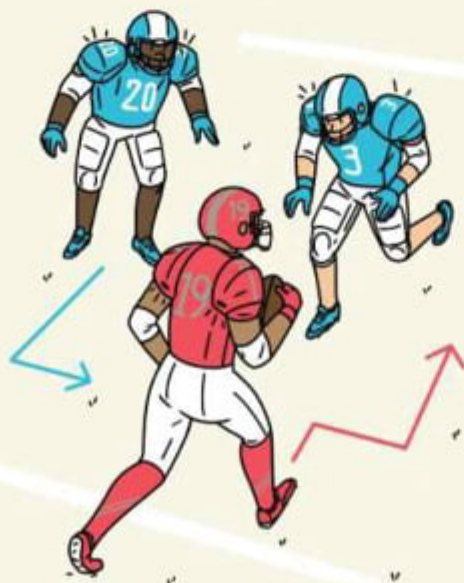
RADIO CHIPS THAT TRACK FOOTBALL PLAYERS

How do you observe multiple stampeding National Football League players? By using Zebra, the logistics company that was appointed last year as the US football league's official "on-field player-tracking provider". Zebra uses electro-magnetic radio-frequency identification, technology that's common in retail, manufacturing and transport, to keep track of inventory and assets – in this case, players. Two penny-sized sensors are implanted in players' shoulder pads; they emit signals 15 times a second, which are picked up by receivers mounted between the upper and lower decks

of the stadium. Unlike regular GPS, which is accurate only to a maximum of three metres, Zebra can pinpoint a player to 15cm, and can even tell which way they're facing. "American football is a contact sport," says Jill Stelfox, vice-president of Zebra. "Any tracking technology must be able to detect and differentiate players in a pile."

Zebra also measures speed, distance covered and acceleration (or deceleration): what the NFL has dubbed "next-gen stats". The data gives fans added insight into live broadcasts and

feeds into the Xbox NFL app. Several teams use Zebra – which can also indicate mechanical load (how hard an athlete is working) during practice. That in turn enables them to tailor personalised training programmes that can monitor progress, manage fatigue and minimise injury risk. The tags are Bluetooth-enabled, meaning that they can be paired with other wearables such as heart rate monitors or patches that gauge hydration. "Player tracking is changing the way sports are watched, coached, analysed and played," Stelfox says. zebra.com

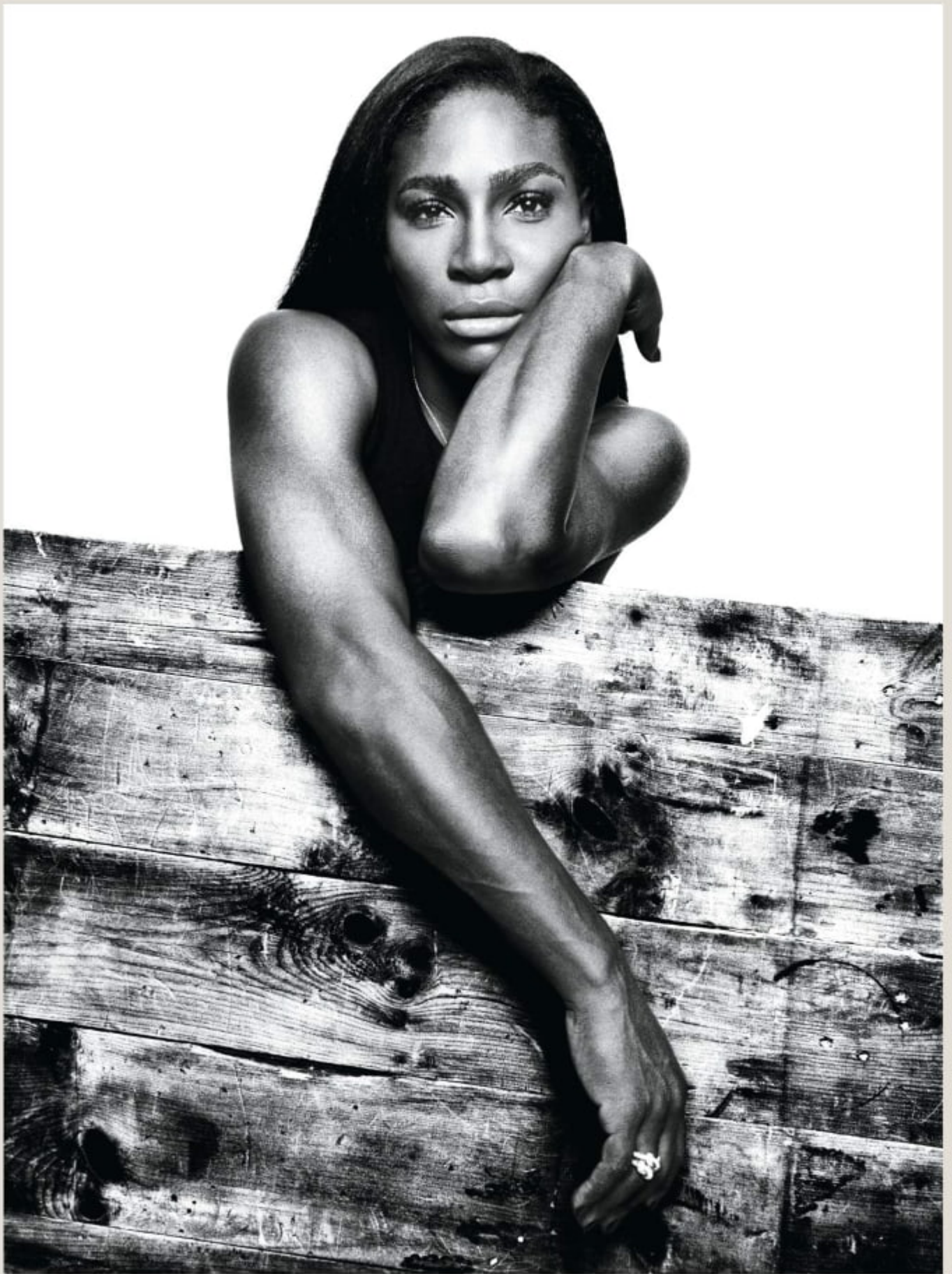


MILITARY TRICKS DESIGNED TO DEFY AGEING

What's the common denominator in the age-defying final flourishes of NFL quarterback Peyton Manning, tennis ace Serena Williams and boxer Bernard Hopkins? Mackie Shilstone.

The New Orleans-based "career extension specialist" is a pioneer of sports science. He used DEXA X-ray scans to measure boxers' bone, muscle and fat down to the nearest gram in the days when most fighters were trying to make weight by sweltering in bin bags. Ahead of the 2015-16 NFL season, Shilstone had the injury-ravaged Peyton Manning analysed by a number of doctors, physical therapists and dieticians. "He asked me if I thought he could do one more year," Shilstone says. "I said, 'I know you can.'" Manning ended the season by lifting the Super Bowl trophy.

Over the past 35 years, Shilstone has honed his methods across a wide range of fields. For instance, he had Serena Williams perform the "run and gun" drills used by US Army Rangers: in combat, soldiers rarely shoot standing absolutely still, and they practise firing their weapons on the move. Shilstone applied this to tennis, developing intense drills where Williams would have to play, say, 20 shots at different points on the court within 45 seconds. His observations of F/A-18 Hornet jet fighters taking off from a dead stop on the deck of an aircraft carrier increased the effectiveness of kickers in the NFL. But, arguably, the career that the spry 65-year-old has been most successful in extending is his own. His secret: rising at 4.30am to spend at least an hour reading medical journals before starting his day. mackieshilstone.com



Serena Williams's career has benefited from Mackie Shilstone's army-inspired fitness drills



4 SCANS THAT QUANTIFY YOU IN 3D

“When people get a scan for a medical reason, if you’re given the data, it’s almost impossible to do anything with it unless you already know what you’re doing,” says Brandon Whitcher, chief scientist at Klarismo, a health startup that lets consumers use medical imaging to understand the physiology and composition of their bodies.

You’ll probably encounter a magnetic resonance imaging (MRI) scanner only for medical investigations. Klarismo, however, sees a missed opportunity. “We want to detach the myth of an MRI scanner and treat it as another piece of everyday technology,” Whitcher says.

Klarismo uses the MRI as a quantitative tool for decision-making, producing highly detailed visualisations of customers’ bodies that measure volumes of muscle tissue, fat and organs. It doesn’t claim to offer the diagnostic quality insight of a CT scan, which a radiologist might look at, but a visual version of the quantified self. “If you want to learn more about yourself, you can scan your whole body, or just do your neck or knees.”

Klarismo is targeting doctors working with elite sports teams: “It’s critical to know exactly how much fat versus muscle an athlete has,” Whitcher says. The price – from £50 depending on the part of the body being measured – is intended to offer an entry point to the non-professional athlete training for an event who wants to know more about their musculature. klarismo.com



DATA ANALYSIS THAT WINS WORLD CUPS

EXOS is a Phoenix, Arizona-based training, nutrition and physical therapy team-behind-the-teams, with clients across a wide range of sports, the US military and first responders. “We’ve been trusted by the best to help them get better,” says Mark Verstegen, founder and president of EXOS. “It’s all about personalisation and prescription.”

EXOS oversaw the victorious 2014 World Cup campaign of the German football side. Only the USA – another EXOS

client – ran further than Die Mannschaft, who collectively covered a mean of 113.8 kilometres in the group stage. In the quarter-final, the Germans ran nearly eight kilometres more than their opponents, France: data suggests this was the equivalent of having three-quarters of an extra player.

But unless you know how to act on this data – sourced from adidas miCoach trackers in the players’ boots – it’s just noise. Verstegen says that there are two questions to ask: “So what?” and “Now what?” EXOS answers these by breaking the data down to get a reading of players’ functional states, stress loads and performance outcomes and then devises individual plans based on this data. The company also works with a number of corporates, such as Intel, to understand employee performance throughout the day.

EXOS works with athletes on the

psychological aspects of their performance, from focusing on intrinsic motivation to performing number tests with the distraction of noisy crowds. Verstegen emphasises the importance of an individual’s thoughts on waking up. “We reprogramme them to run through how their winning day will go, make their first movement about breathing, hydrate and fuel their body and mind and do their specific prehab mobility and stability activation,” Verstegen says. “If we clean up this first ten minutes, it makes everything they do better.”

EXOS tidies up the final minutes too, conducting sleep research with the US football team. “Optimising a player’s sleep hygiene is a powerful way we can upgrade performance, decrease injury and improve cognitive function,” he says. athletesperformance.com



Mark Verstegen
trains German
striker Mario Gómez



BREAKING RECORDS

THE MAN AIMING TO SMASH THE TWO-HOUR MARATHON

With the world record for the marathon standing at 2:02:57, the two-hour barrier is within reach. Yannis Pitsiladis, professor of sport and exercise science at Brighton University, believes it will be breached by 2019 – and he's on a quest to do just that.

His SUB2 project began in 2014, seven years after he and a team of researchers observed the preparations of elite athletes in Ethiopia and Kenya, the world powers of distance running. "There was literally no scientific aspect [to what they were doing]," he says. "We thought: imagine what they

could do with the best ideas available."

He assembled a team of trainers, nutritionists, biomechanics specialists and data scientists to work on every aspect of the athletes' performance. One of the biggest obstacles is not physical but mental: in the absence of evidence that it can be done, athletes apply a psychological handbrake called "programming". Conversely, when a record is broken, the old record can suddenly be repeatedly beaten.

SUB2's ambitions go further than just breaking a record. It aims to reinvigorate public interest in elite marathoning, partly by busting the myth that it's exclusively the domain of

east Africans.

And doing the unbelievable clearly will help restore the reputation of athletics. The SUB2 committee hopes to bury *Chariots of Fire* amateurism with a norm of professional athletes supported by teams of sport-science experts: "Rebranding and modernising athletics are really what we want," Pitsiladis says.

SUB2 also aims to fast-track innovation. Pitsiladis declares himself frustrated with the pace (and efficacy) of advances in sport science. It's not just only spin-offs such as running trainers: SUB2, he says, could lead to giant leaps in molecular technology, personalised medicine and injury treatment. sub2hrs.com

7 THE FILTER THAT SPOTS TRAINABILITY

As UK Sport's deputy director of performance, Chelsea Warr saw potential in the current world number-one rower Helen Glover – who won Team GB's first gold at London 2012 – and skeleton bobsleighter Lizzy Yarnold, who last year completed a grand slam of Olympic, European, World Championship and World Cup titles. But it's Lutalo Muhammad's bronze in taekwondo at London that, says Warr, is "particularly special".

"It shows that the principles don't just apply to the big 'CGS' sports – those measured in centimetres, grams and seconds – but also technical ones," says Warr, who is now a non-executive director at the UK Lawn Tennis Association. For instance, Glover, who's 1.78m, stood on tiptoes to gain entry to Sporting Giants – Steve Redgrave's talent programme – to beat the cut-off of 1.80m for the programme. "It's like a frequent-flyer club: you need a certain amount of points," Warr says. "But then we look at who can become a gold, silver or bronze member." Intangibles such as "the right stuff" become metrics, she says. "Over time, you can measure commitment."

Warr has examined how elite organisations determine who makes the cut. One lesson has been the importance of trainability. "Someone's starting level is not highly predictive of what they can do," Warr says. "How they respond is far more accurate." A meticulously planned curriculum is key. "At the Yehudi Menuhin music school, they had a big board with what each child had to do for every hour of every day to become world class. It's by design, not luck," Warr says.

With Bangor University, Warr studied the psychology of serial medal-winning "super elite" athletes. "We charted them from the age of six to when they became champions," Warr says. Research is underway into accelerating learning. "One of the best ways is making mistakes," says Warr. "But coaching programmes don't always encourage that." Fail smart, win fast. uksport.gov.uk/talent

6

DESIGN TWEAKS THAT REINVENTED THE WHEEL

Lewis Hamilton and the Mercedes AMG Petronas Formula 1 team have rethought the steering wheel. It might look like an Xbox controller on performance-enhancing drugs, but it's designed like this for a reason: all the critical controls need to be within reach of Hamilton's thumbs so he doesn't have to move his hand from the custom grips while taking a corner. (Those at the bottom are for when he's on a straight.)

F1 steering wheels have been getting smaller and less circular for several years – it's more efficient and safer for a driver not to turn through 360° or go overhand. Losing sections of the wheel saves weight without sacrificing stiffness, thanks to advances in carbon fibre. Mercedes' drive to lighten the load extends to the thinness of the rubber coating – which is relatively heavy – on the myriad buttons. The material cost of the wheel is estimated to be £40,000.

The wheel has to be removable in case of mechanical failure and for safety reasons. Most settings are stored in the computers in the vehicle – although a backup has to be programmed. Every driver has preferences, meaning each steering wheel is set up as a bespoke piece of kit. mercedesamgf1.com

1. DIFFERENTIAL

Differential is used to adjust torque during turns. Hamilton adjusts this a lot in a race because the car's balance alters due to tyre wear and fuel load.

2. OVERTAKE

Like hitting the nitrous oxide button in *The Fast and the Furious*, this pushes the power unit into its most dynamic mode when top acceleration is needed for passing.

3. SKIP 1/10 PRESET

This allows Hamilton to interact with the car's 100 control sensors, either to switch off a faulty one or turn another on for strategic reasons.



8. ACCEPT

This confirms the modes selected by the Skip 1/10 buttons. It also triggers the clutch biting-point finder. Many of the buttons are multiplexed to save space – increasing the number of permutations to several billions.

9. DRS

The Drag Reduction System is an adjustable rear wing that delivers an aerodynamic speed boost of 10–12kph. It's only permitted within certain zones, and within one second of the car in front.

10. STRATEGY ROTARY

Rather than having individual levels, this "go-faster" switch enables Hamilton to flick between a high-performance setting for an all-out qualifying lap and a more energy-conserving one.

4. GEARBOX NEUTRAL

To avoid accidentally putting the car into neutral at speed, it is located on the front of the wheel, rather than on the gearshift paddles at the back.

5. PIT-LANE SPEED;

6. PIT CONFIRM

This limits speed to 80kph for the protection of the pit crew, and alerts them to prepare for a stop without requiring radio notification.

7. TORQUE

This is used to select throttle "maps": if Hamilton puts his foot down he'll get all the torque; at halfway he may get more or less than half, depending on whether he wants it aggressive or gradual.



11. MENU ROTARY;

12. HPP ROTARY

Controlling settings for the chassis and power respectively, these switches have 14 positions that each correspond to a different menu of options – that is, they're equivalent to 14 other rotaries.

13. MARK

Hamilton can flag a point in the data – for instance, a sub-optimal corner or a harsh-sounding gear change, for later analysis.

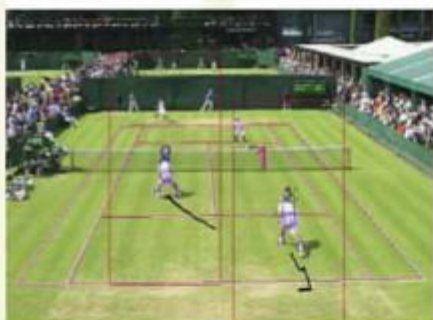
14. RADIO

A crucial piece of kit for Hamilton to communicate with the team. New rules limit what data can be broadcast, thus increasing what's displayed on the wheel.



9 TRACKING TECH THAT CAN ENABLE PLAYER EMPATHY

It's tempting to imagine that Paul Hawkins – creator of Hawk-Eye and a talented cricketer – was moved to invent his ball-tracking technology after becoming the victim of an unjust leg-before-wicket decision. "That's a part of it," he says. "Most of our company's innovation has been application-led. I've got a PhD in AI, but more importantly I've played cricket all my life and



understand what the game needs."

What it needed was multiple cameras to determine where a ball is in space, enabling predictive data to be generated to show what it would do next. Hawk-Eye doesn't claim to be infallible – just very, very reliable. It has a margin of error of 5mm in cricket and 2.2mm in tennis. "It's basic maths but people struggle to accept things they don't understand," Hawkins says.

"We started being used officially by the [cricket] umpire in 2005 and we've made four mistakes since, none of which would have affected whether the batsman was out or not. I'm not sure if we're 99.99 per cent accurate, but we're certainly 99.9 per cent," Hawkins says.

From line calls in tennis to goal-line technology in football, Hawk-Eye is now an integral part of the spectator experience when watching sport live. It's debatable which sport the Basingstoke-based company – which

was bought by Sony in 2011 – has changed most. "Tennis has perhaps had the greatest impact from the entertainment side," Hawkins says. "Football is probably the most advanced from an engineering perspective, and it's paving the way for other technology in the game, so it may yet have greater impact."

Hawk-Eye is now being used to officiate NASCAR, horse racing and even hurling. But arguably its biggest contribution is in making sport more exciting through its now-iconic graphics. "The biggest thing that we haven't yet done – and we do have some ideas for it – is telling the story of the pressure that someone is under," Hawkins says. "Imagine showing what was going through Andy Murray's mind when he was serving to become the first British man to win Wimbledon for 77 years... I can relate to that. Even at my level." *hawkeye innovations.co.uk*

Top: Hawk-Eye is used in more than 80 tennis tournaments

10 A £2,000-A-LITRE SPORTS DRINK FOR ENDURANCE

Popular in performance nutrition circles for some time, ketones are chemicals produced by the body when people are fasting or following a ketogenic (low-carb, high-fat) diet. They provide an alternative, rapidly used fuel source, forcing the body to



In tests, the drink enhanced performance in rats and humans

burn fat tissue instead of sourcing glucose from carbs. Now they're being produced by University of Oxford researchers for use in a sports drink, designed to prevent athletes hitting the dreaded "wall". Existing products claiming to provide exogenous (ie external) ketones commonly contain high levels of salt or acid and are a "scam" because they're not actually absorbed by the body, according to Kieran Clarke, professor of physiological biochemistry. "They're not metabolised," she says. "We made the ketones into an ester, a type of food we normally eat, which is digestible."

Although Clarke's new nutraceutical has already enhanced elite athletes' stamina in studies to be published this year, she says she has rejected overtures from various professional sports teams while she awaits approval by the UK Food Standards Agency. Another ketone caveat is that they're only really superior to fast-action glucose (sugar) drinks for endurance sports. Then there's the prohibitive cost – currently around £2,000 a litre. "At the moment, we're still making it in the lab, which is very labour-intensive. With scale, the price will go down," says Clarke. "But it's still going to end up being the Rolex of supplements." *tdeltas.com*



TOOLS DESIGNED TO WARM UP THE MIND

"We didn't think about products or markets once," says Halo Neuroscience co-founder and CEO Daniel Chao. "We wanted to let the data lead us to our first application. We were probably more research institute than startup."

Halo focuses on the motor cortex, which controls co-ordination. Its programme involves three components:

the *Halo Sport* app; Halo Sport, a pair of what look like regular headphones; and Primers, foam "nibs" which sit on the headband and deliver pulses that help neurones fire together.

Halo offers a warm-up for the athlete's mind: you put the headphones on for 20 minutes before a workout. Pulses have been found to increase brain plasticity, or its ability to make new circuits. "Why we do reps in the gym or on the training field is not just to build the body," Chao says, "but so that the brain becomes automatic

and, in competition, you can call on it."

Psychologists work on the "software" of the brain – motivation, say. But little is done to upgrade the "hardware". The potential is significant for making athletes go faster and further with more efficient training.

The firm is working with the military and medical industry. "We're treating stroke victims," Chao says. "To the extent that we can help LeBron James jump higher, we can help people walk again." *haloneuro.com*

PHYSIOLOGY

A GYM BUDDY THAT MEASURES FITNESS SESSIONS

Hardware designers Dhananjan Jayalath, Chris Wiebe used to hit the gym together when they were students. "We

wanted a way to work out better and get more out of our time at the gym," says Jayalath. Backed by \$3.5m (£2.4m) in seed funding from Chamath Paliapitiya, the pair co-founded Athos, a system of smart clothing with sensors that measure how the body is performing when exercising.

The clothing syncs with an iOS app that measures how muscles are firing in order to measure exertion levels. "If you introduce technology into somebody's routine, it's more likely for them to adopt it than if they have to build a new habit around it," says Jayalath. *liveathos.com*





Land Rover's T3 on its maiden voyage, off the coast of Portsmouth

13

THE TEAM THAT RELIES ON IP TO SUCCEED

The oldest international sporting trophy, the America's Cup, is a technology arms race: a £7 million hydrofoil craft is attached to Boeing 737-sized wings hovering above the water with as little as one per cent of their surface area immersed – at speeds three times faster than the wind that's propelling them. Nowadays, Formula 1 manufacturers are restricted by exact design regulations, but there are no such rules in the America's Cup, enabling teams to innovate. Which might be the reason that Martin Whitmarsh, the former principal of McLaren, and Adrian Newey, the chief technical officer of Red Bull, have joined Ben Ainslie Racing, the team set up to win the competition for the UK. Whitmarsh is CEO and Newey has a consultancy role.

Although the team is focusing on victory in the final set of races in Bermuda in July 2017, Whitmarsh is thinking more long-term, with a move to a new base in Portsmouth (partly inspired by McLaren's iconic Technology Centre) and away from the campaign-based approach to previous America's Cups. "We're building a team and facilities that enable us to manage technical IP, which is the strength of any F1 team, or any technology company, from Apple to Toyota," Whitmarsh says. land-rover-bar.americascup.com

14

THERAPY THAT SLASHES RECOVERY TIMES

"Anterior cruciate ligament ruptures are no longer necessarily career-ending," says Mike Davison, UK managing director of Isokinetic, a sports-injury treatment specialist, one of 42 FIFA-accredited centres worldwide. "Athletes can come back stronger, both physically and

psychologically."

In the past, orthopaedic surgery was common for many types of sports injury. Now, physical therapy is used instead of the knife. Cruciate ligament damage used to mean athletes could be sidelined for a year after surgery. Now, with six to eight weeks of pre-op physical therapy, some skiers are back in action after three months.

The centrepiece of Isokinetic's London premises is the Green

Room – covered in AstroTurf and kitted out with high-speed cameras that assess an athlete's readiness to return. According to Davison, one of the biggest causes of injury in footballers is poor internal communication at clubs. Which is why Isokinetic has a holistic approach towards recovery: "Overall well-being, reduction of injury risk and mental resilience are baked in," Davison says. isokinetic.com

15

EDITING SOFTWARE THAT PROVIDES ADDED INSIGHT

Who needs the benefit of hindsight when you can instant-replay what's happening during a match?

That's what is offered by Hudl, video-editing software that's being used by 130,000 sports teams worldwide. "Our motto is: If you can record it, you can learn from it," says Hudl CEO David Graff. The app – which received \$72.5 million in series B funding led by Accel in April

2015 – allows users to annotate a game, pinpointing particular key passages of play, which makes it easier to review outcomes. It's possible to customise the technology – professionals have tailored it for their particular needs – but it's also used by amateurs, from high-school teams to cheerleading squads to get a view of their performance.

Its instant-replay service, Sideline, includes a portable router that circumvents the network problems of packed stadia. An iPhone will suffice as a camera and footage can be reviewed on a tablet. "We aim to get that clip ready for review in less time than the play itself lasted," Graff says. "The same goes for uploading – we want it online and ready to study within minutes of the game ending." This means that post-game analysis can start on the coach on the way home,

in previously dead travelling time – athletes no longer have to come in the next day to review tapes.

With little media coverage or marketing, the Lincoln, Nebraska-based company has grown through word of mouth. Players can create their own accounts and make highlights packages – in the US, some college athletes have been signed on the strength of their reels. Hudl has also been selling pre-roll advertising against popular clips and licensing them to media such as ESPN and Bleacher Report, and is moving into association football. Graff's ten-year goal? "To capture and bring value to every moment in sport." hudl.com 

Jamie Millar is a freelance fitness and fashion writer



A full-page photograph of a male athlete with extensive tattoos on his arms and chest. He is wearing a blue and white baseball cap, black athletic shorts, white compression leggings, and bright orange and black sneakers. He is captured in a dynamic, mid-air pose, leaning forward with his arms outstretched. The background is a wall made of large, rusted metal panels with visible rivets.

BY **JOÃO MEDEIROS**

HIGHER, FASTER, FITTER, BETTER

PHOTOGRAPHY: **CODY PICKENS**

**WHETHER DIVING THE OCEAN
OR FALLING FROM SPACE, RED
BULL'S HIGH PERFORMANCE
CENTER KNOWS HOW TO GIVE
COMPETITORS THE EDGE**

MILES CHAMLEY-WATSON IS GRUNTING IN PAIN. THE FENCER IS IN THE GYMNASIUM,

standing next to a dummy hanging

from a rig and strapped to weights on the ground, and he is suffering from toothache. Chamley-Watson, a slender 1.93-metre-tall athlete, is in full fencing garb and holds a foil – one of three types of sword used in the sport – with his right hand. The American flag is painted across the mesh of his mask. Although he was born in London, Chamley-Watson fences for Team USA and, in 2013, became the first American fencer to become world champion. He's a medal contender for the 2016 Summer Olympics in Rio. Chamley-Watson looks at the dummy hanging before him and grimaces. "I can compete with broken fingers; that's nothing compared to a throbbing pain in the tooth that you can't do anything about," he says. "Still, I'm going to destroy this dummy."

The gym is the Red Bull High Performance Center, a 270-square-metre space inside the company's North American headquarters in Santa Monica, California. It's a vast red-brick building that includes a cinema, recording studio and gaming room. Here, the Red Bull-sponsored athletes are looked after by a team of performance experts and use an extensive assortment of equipment. In one corner is a large trampoline where skateboarders, surfers and gymnasts improve their acrobatic skills. Next to it is a Formula 1 simulator. There's also a neurological training system with a headset that measures brainwaves, a sensory-performance station where athletes can test ten perceptual and visual-motor skills using a touch screen and strobe glasses, an anti-gravity treadmill, a cryosauna – a therapeutic chamber in which the body is subjected to cold temperatures – and a lab equipped with stationary bike, treadmill and breathing masks where lactate thresholds and lung capacity can be measured.

This chilly March afternoon is Chamley-Watson's second day at the

centre, part of his introduction to Red Bull's High Performance Program. He has already conducted a battery of physical exams, neurological assessments and an extensive blood test that tracked more than 200 nutritional biomarkers for a range of medical conditions. Now, he is warming up for the final test. Opposite the dummy a film crew is setting up a high-speed Phantom camera. "So far the tests have been surreal," Chamley-Watson says. "There's no one in the fencing world doing this kind of stuff. I want to come back for a week. I'll come out looking like the Terminator."

Chamley-Watson spends the next few hours relentlessly attacking the dummy with his foil: from the back; from the front; with mask; without mask; using different types of strike; and attacking angles. As he watches slow-motion replays of his movements, he begins

'THE FACT THAT MERCER GOT TO THE LIMIT WAS GREAT. PAY ATTENTION TO YOUR ENVIRONMENT. CHECK IN ON YOURSELF. DON'T GET COCKY'

to notice aspects of his movements that he has never seen before – how his eyes focus on his target when he attacks, and how he tends to strike the dummy only after his front foot makes contact with the ground. "It's supposed to be strike, then foot," says Tyler Jewell, a Red Bull high-performance consultant. "Miles realised that he was telegraphing his

movements. He started thinking about his technique right there and then."

Towards the end of the session, Chamley-Watson executes a beautiful balletic movement. He taps the dummy twice with his foil, then lifts his left arm, swivels slightly and strikes the target from behind his back. A huddle forms around the camera to watch the replay. Slow motion, particularly at a speed of a 1,200 frames per second, makes the movement even more elegant. A handful of people cheer with delight. "That's your *Magic Mike* shot right there, dude," Jewell says.

Red Bull's inextricable association

with sports can be traced back to its founder, Austrian businessman Dietrich Mateschitz. It was in 1982, during a sales trip to Thailand, that Mateschitz, then a marketing director for German cosmetics company Blendax (now part of Procter & Gamble), first tried a local tonic called Krating Daeng, which helped to alleviate his jet lag. The drink contained water, cane sugar, caffeine, B vitamins, inositol and taurine, an amino acid. Its logo depicted two red bulls charging head to head against a backdrop of the Sun. In Thai, "Daeng" means red; and "Krating" means gaur, a type of bull native to Thailand.

At the time, Krating Daeng was a favourite of factory workers and truck drivers who had to endure long night shifts. It was also a ubiquitous sponsor of Thai-boxing matches. The energy drink, which launched in 1976, had made its inventor, former antibiotics salesman Chaleo Yoovidhya, a billionaire.

Mateschitz proposed to Yoovidhya setting up an independent company that would expand the energy drink into international markets. In 1984, he founded Red Bull GmbH in Fuschl am See, Austria. Mateschitz spent the next three years pondering the company's strategy and tweaking the original flavour to better suit western tastes before launching the drink in Austria.

But given Mateschitz's proclivity for action sports, perhaps Red Bull's early

Right

Olympic slopestyle skier Nick Goepper undertakes agility training at the High Performance Center



marketing alliance with sports was inevitable. The Austrian businessman was a dilettante athlete who spent his holidays mountain biking, windsurfing and snowboarding with some of Austria's top athletes. In 1989, he convinced Gerhard Berger, the Austrian Formula 1 driver teamed with Nigel Mansell at Ferrari, to become the first athlete to be sponsored by Red Bull. Today, Red Bull owns two Formula 1 teams, football teams in Salzburg, Leipzig, São Paulo and New York, and sponsors more than 750 competitors in over 150 sports, including triathletes, motocross champions, ultramarathon runners and skateboarders.

Not all US-based Red Bull athletes participate in the High Performance Program. Those who do, such as Chamley-Watson, are part of one of the world's most sophisticated and experimental training programmes, whose partners include institutions such as Cirque du Soleil, Intel, elements of the US Department of Defense and a vast network of universities and scientists. "We have all this talent and from the start we made a focused decision to learn as much from them as we could, to test them and understand their mastery," says Andy Walshe, Red Bull's director of high performance. "We started collecting data without knowing what we were going to do with it. Blood work, brain scans, fitness data, psychometric questionnaires... It's not big data, it's complex data and we're just focusing on collecting as diverse a range as possible."

Walshe, who's Australian and has a PhD in human movement studies, started the programme in 2007. When he arrived he already had a reputation as an innovator, earned after nine years as the director of high performance for the US Ski Team, during one of the most successful periods in its history. "When I arrived we were seventh in the world rankings," Walshe says. "When I left we were competing for first. We started with just me and another guy and built up a full staff of performance scientists and coaches. At Red Bull, I had to go through the same process at the start. There was nothing, just me in an office with a few athlete marketing managers. I thought to myself, 'Fuck, did I just give up the best job in high performance for this?'"

But Red Bull had something that Walshe wanted: a different type of athlete. Surfers, skateboarders and many other athletes who had never had coaches or support staff and yet were the best in the world in what they did. This intrigued Walshe. One

afternoon shortly after he joined Red Bull, he took a stroll down to Venice Beach and sat down at the skate park to watch the skateboarders. "They were trying to jump and ollie down a huge set of stairs and they were just crashing, crashing, crashing," Walshe recalls. "The crowd was cheering. The bigger the crash, the louder the cheers." Walshe hadn't seen this amount of failure in sports in years. These kids weren't just failing, they were celebrating the failure. It reawakened

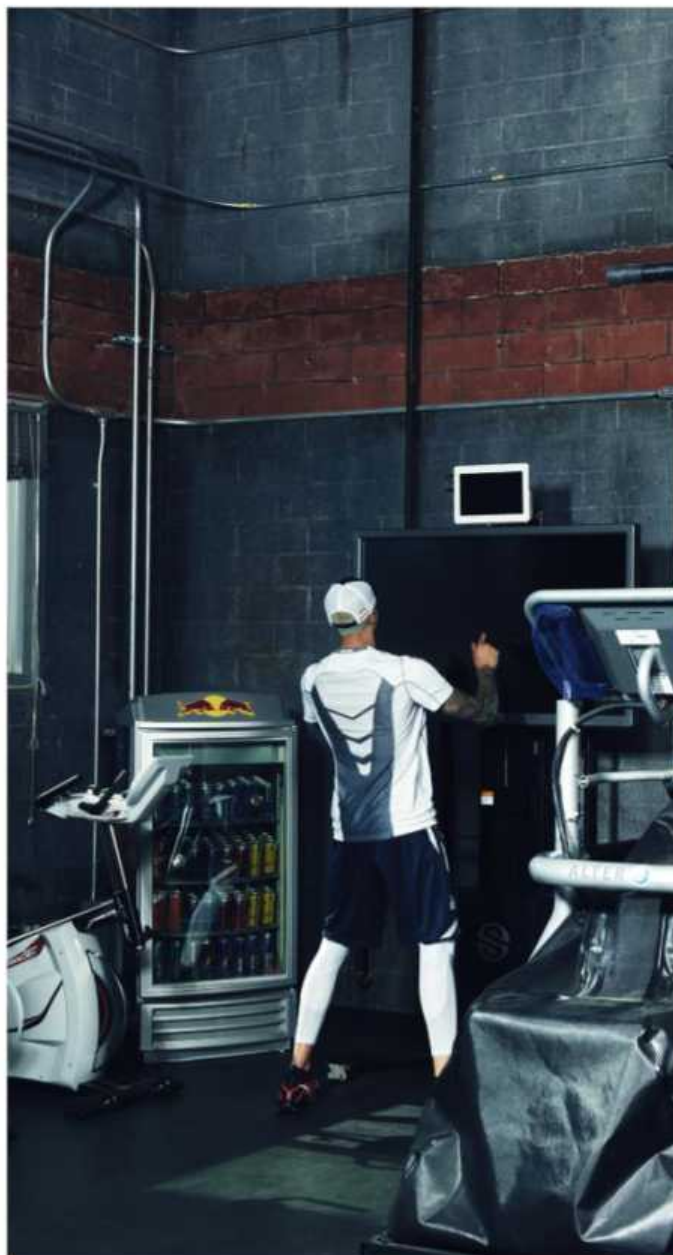
a concept that Walshe knew about from college called discovery learning. "Say you teach the forward roll," he says. "You can give specific instructions. Or you can set up an environment like a playroom with mats and let people play. You generate cues that lead to the idea of what you want them to do, but you don't teach them directly. The environment reinforces the right behaviour and they self-discover the extent of the lessons. In high-performance teams, we'd lost that."

THE RED BULL WAY



1. **Breath-Hold Camp**

The first Breath-Hold Camps were designed to teach surfers how to sustain their breath for an average of four minutes. When Red Bull's coaches discovered that athletes were also using these techniques to manage stress levels and break psychological barriers, they expanded the camps to include skiers, snowboarders and other action athletes. Breath-hold exercises are now part of the Performing Under Pressure Camps.



Above right
Enduro motorbike rider and Project Acheron II participant Tarah Gieger gets pushed to the limit

Walshe embraced failure as one of the principles underpinning a performance programme with the clear mandate of supporting the athletes in whatever they wanted to achieve. One of his first projects involved BMX riders Mikey Day and Jill Kintner. "They wanted to get ready for the Olympics," Walshe recalls. "I'd never worked with BMX but I was comfortable with Olympic programmes." At Beijing 2008, Day and Kintner won silver and bronze. The Red

Bull High Performance team launched training camps for snow and surf and began accruing successes with projects such as motorbike stunt rider Robbie Maddison's New Year's Eve 2008 jump to the top of the Arc de Triomphe in Las Vegas in front of 50,000 people. "It took about six months to get that right," Walshe says. "We built a platform and stepped it up ten feet at a time. He had a foam pit – we allowed him to fail. The practice was centred on progression and failure."



autumn 2010, Richard Ingelhoffer

popped into Andy Walshe's office. Ingelhoffer was the personal manager of Austrian stuntman Felix Baumgartner. He was looking for a stationary bike and someone had told him that Walshe would be able to help. Behind Walshe's desk, Ingelhoffer noticed posters depicting the projects Walshe had been running. "What the hell is all that stuff?" Ingelhoffer asked. Walshe told him about High Performance. Within a week, he was on a plane to Austria to meet Baumgartner.

Baumgartner was involved in a separate Red Bull project called Stratos, whose mission was to carry him to an altitude of 39km, from where he would jump back to Earth. If successful, Baumgartner would break the record for the highest-ever free fall and become the first freediver to break the sound barrier. Baumgartner's team included aerospace engineer Art Thompson, who had worked on top-secret projects such as the B-2 stealth bomber, and former US Air Force captain Joe Kittinger, who broke the then sky-diving altitude record in 1960 when he jumped from a height of 30.5km. Unlike Baumgartner's previous undertakings, Project Stratos wasn't a stunt. It was a bona fide test-flight programme.

That this test flight happened to be run by an energy-drink company partially explains the problems that Walshe encountered when he joined Stratos. By then, the project was behind schedule, Thompson had been fired and rehired, and Baumgartner had developed a phobia of the pressure suit so severe that, shortly before the first test in 2010, he had called Thompson, in tears, to inform him that he was returning to Austria. Baumgartner also asked Thompson what the Air Force did to help pilots afflicted by this sort of



2.

Project Acheron: Snow

Named after the river that borders Hell in Dante's *Inferno*, the first Acheron took athletes led by former US Navy SEALs on a tour across Patagonia. The second took four female athletes to the Australian outback for extreme hiking, kayaking and freediving.



mental block. They get rid of him and bring in the next guy, Thompson replied.

Baumgartner remained, and Red Bull brought in Walshe and his team to help him. "Felix had gone home and the programme was shelved," Walshe recalls. "The environment was getting tough. Confidence was lost and people were asking when or if this was actually going to happen."

For two weeks, Walshe, his team and a psychologist called Mike Gervais worked with Baumgartner to help him face his fear of the pressure suit, slowly working up to the point where he was comfortable in it for more than six hours inside a depressurised capsule. "We said to him, imagine yourself in 40 years telling this story to your grandson and what kind of story you want to tell," Walshe says. Walshe ordered a metal plaque to be made etched with the words "How do you want to be remembered?" and affixed it to Baumgartner's cabinet.

Project Stratos was completed on October 14, 2012, when Baumgartner ascended to an altitude of 39km, sitting inside a capsule built by Thompson and lifted by an inflated helium balloon.

"I'm ready to jump," he told mission control. "You were born ready, Felix," was the reply.

Baumgartner rolled the capsule's door open, disconnected his oxygen hose and stood on the step into space. "I'm coming home now," he said.

To Red Bull, Stratos was a project with deadlines that had to be met. To the engineering crew, it was a flight-test programme whose mission was to achieve something that had never been achieved before. And to Baumgartner, a stuntman who'd made a career of operating on his own, the cumbersome and claustrophobic pressure suit had become the symbol for the tug of war between his need for autonomy and his dependency on the crew. "I saw in Stratos what I had seen in the skateboard park," Walshe says. "Flight-test programmes are a series of incremental steps designed to push the equipment and staff to the point of failure, so that you find where the system needs correction. And that is exactly what learning skateboarding tricks is all about. You fail and fail until you figure out what you need to correct then you improve."

Project Stratos gave Walshe the impetus to come up with another programme that would train athletes for the unknown element of extraordinary undertakings. "It's not about breaking them," Walshe says. "That's easy. It was about crafting a learning

experience that allowed them into an unknown environment they had to adapt to. We built in elements of military training, doubled down on the science and tried to build a once-in-a-lifetime experience." The result was Project Acheron. Its working title: "How To Toughen The Fuck Up".

That wasn't something that Australian triathlete Jordan Mercer was told when, in April 2014, she received an invitation from the Red Bull High Performance Group to join Project Acheron II. All she knew is that she had been selected along with three other Red Bull female athletes – freestyle mountain skier Michelle Parker, skier Grete Eliassen and Enduro motorbike rider Tarah Gieger – and that they would be accompanied by two former Navy Seals. Mercer, 20 at the time, was the youngest. "I had heard about how gruelling the first Project Acheron had been," Mercer says. "I also knew it had taken place in the snow. I'd never been to the snow so I was pretty excited about that."

Project Acheron II began in Broome, northwest Australia, on September 1, 2014 at 3.30am. "They woke us up and ushered us to a Jeep," Mercer says. "We still had no idea where we were heading." After a short ride, they pulled into Broome International Airport. The athletes realised that they would be jumping out of an aeroplane only when they walked into the airfield and saw a skydiving crew holding parachutes. They flew for a few hours. Mercer felt

Left

Team USA fencer Miles Chamley-Watson, US flag-embazoned mask in hand, has his own signature combat move: the Chamley-Watson

nervous and uncomfortable, strapped up to the parachute and the skydiver who would be jumping with her. It was still pitch black outside. "We had been flying for an hour when the Sun rose. It looked incredible," Mercer says. "I had never seen anything like that." Then she noticed that the door of the aircraft was open. Michelle Parker went first. "She just flipped out of the plane and I started screaming," Mercer says. "A shriek like I've never even heard myself make before." Before she knew it she was being pushed out of the aeroplane, into the open sky.

They landed on a mushy patch of thick shrub in the middle of Prince Regent National Park in the Kimberley region of northwestern Australia. After

'THERE'S NO ONE IN THE FENCING WORLD DOING THIS KIND OF STUFF. I'LL COME OUT OF THIS CENTRE LOOKING LIKE THE TERMINATOR'

Right

Freestyle mountain skier Michelle Parker takes part in a co-ordination exercise



3. Project Stratos

On October 14, 2012, Austrian daredevil Felix Baumgartner freedived for 50 seconds when he jumped to Earth from an altitude of 39km. Trained by Andy Walshe, the 43-year-old became the first person to break the speed of sound unassisted.

landing, they were approached by Leah Umbagai, an Aboriginal woman, who performed an ancient ritual that involves burning plants whose smoke wards off bad spirits. They then started walking in single file into rugged untracked terrain, dotted with boulders and covered in two-metre-high spinifex grass that had to be cleared with a machete. It was 42°C. A few hours into the hike, Mercer hit her lowest point. “I never enjoyed walking,” Mercer says. “It was my worst nightmare – walking with uncomfortable shoes, wet pants and a 25-kilo backpack.”

For the next four days of hiking, they averaged 16km a day. They were sleep deprived, had blisters and had been attacked by ants. “You’re so tired you get delirious,” Mercer says. “My legs were beyond jelly. I had to lift them when we were climbing.”

At the end of the fourth day, they camped on the top of the King Cascade Falls. In the darkness, the group spotted a red light approaching. “I was pretty scared,” Mercer says. “We were so exhausted that I didn’t react. So I’m eating a chocolate bar and watching my life flash before my eyes.”

The approaching menace turned out to be Walshe. The next day, the group travelled to the top of Mount Waterloo, where they met Leah Umbagai again. “She told us stories about her people and her land,” Mercer says. “The thing I took away from it was that if you respect the land, the land would look after you.” They camped atop Mount Waterloo and sailed south to Freshwater Cove the next day. There they were given tents, a radio, a stove and a pot and told that they would be sleeping in isolation from the rest of the group.

On day eight, Umbagai performed an exit smoking ceremony. The group headed north. “I thought it was over,” Mercer says. “But they told us we should rest. I said, ‘Are you serious?’ Then they told us it wasn’t over.”

The next day, they performed an exercise which consisted of holding their breath, pulling themselves down a rope to the sea bed 22 metres below and returning to the surface. Mercer was in her element. She dived down the line, took out her GoPro and started walking on the ocean floor. She was calm. But she felt a very strong urge to breathe. “It sounds silly, but I forgot that I was underwater,” Mercer says. Then she did the number-one thing she wasn’t supposed to do. She panicked.

RED BULL

first included breath-hold exercises

as part of a training camp with Ian Walsh called Surf Survival. A few years ago, Walsh could, at best, hold his breath for about 40 seconds, an expected duration for someone who was regularly wiped out by ten-metre waves. At his request, Andy Walshe contacted Kirk Krack, the head of Performance Freediving International, a Hawaii-based school which teaches freediving and breath-holding techniques. “The Navy had developed programmes for breath hold under stressful circumstances like helicopter crashes in the ocean,” Walshe says. “We adapted elements of both.”

In October 2010, Walsh, Walshe and a few surfers flew to Hawaii’s Big Island for Red Bull’s first breath-hold camp. For four days, Krack taught them the theory of breathing techniques and the psychology of water survival. They then practised static breath holds in a swimming pool, where they learned how to control and lower their heart rate to preserve oxygen. To simulate being pounded by waves and the subsequent feeling of disorientation, the surfers were thrown around at the bottom of the pool while being blasted with gas from an air tank shooting in their faces.

“We also threw Ian [Walsh] off a cliff into the ocean,” Walshe says. “He would swim back up and, as he got to the surface, I would pull him back down to get that second hold-down effect.” By the end of the course, Walsh was able to deep-dive 36 metres and hold his breath for more than four minutes. “Although we were doing this for Ian’s safety, we started to realise the power of what we were teaching,” Walshe says. “Breath holding is actually a tool to break into perceived mental limitations, the difference between perceived and actual ability and the personal outcome of internal dialogue and self-doubt.”

Soon, Red Bull started extending its breath-hold camps in Hawaii to other athletes. “We took four snow athletes there,” Matt Christensen, Red Bull’s air awareness coach, says. “One of the girls was from Montana and this was

the second time she’d been to the sea. He had to start with the very basics: ‘OK, so this is a diving mask...’ Kirk had to change his whole course because the girls had no experience.” In 2014, they organised a second camp with ten athletes, including Jordan Mercer. When it came to the final dive, Mercer went down to the bottom with motorsports legend Travis Pastrana. “They had Red Bull cans with them and cheered, and when he was ready to go up, she stayed down there having fun,” Christensen says. “She’s like a little fish. Badass.”

Walshe’s role during the breath-hold exercise at Project Acheron was to watch over the athletes. He recalls the moment Mercer emerged from the sea. She was at first euphoric, then her lips went blue and her head rolled back. She blacked out. Grete Eliassen, who was standing nearby, held Mercer’s head, removed her mask and tapped her cheeks. Within seconds she had regained consciousness. “The fact she got to that limit was great,” Walshe says. “Pay attention to your environment. Continuously check in on yourself. Don’t get cocky.”

During the 2014 breath-hold camp, Walshe began entertaining the idea of organising another camp that would challenge the participants on a purely psychological level. “If we keep just pushing athletes to their physical limits the result is just bigger waves and higher cliffs,” Walshe says. “At some point, someone would get killed.” To Walshe, the breath-holding exercise helped athletes to overcome mental



4. Performing Under Pressure

The first PuP camp was in October 2015. Its goal: to push the limits of the 12 participants and improve their ability to deal with high-pressure situations. Activities included mindfulness classes, breath-hold training and speed racing.





Above
Skateboarder Felipe Gustavo emerges from the Red Bull High Performance Center's cryosauna

Left
League of Legends player Bunny FuFuu, with EEG-recording cap, undergoes brain training


limitations without a demanding physical component, so he asked his team to start brainstorming similar ideas. "We didn't have much time," Matt Christensen recalls. "You have to be creative and sometimes we have crazy ideas like throwing people into the ocean from a helicopter to see how they respond. Of course, there's no way that we're allowed to do that. But imagine if we just did it anyway, then you beg for forgiveness. We might be out of a job but wouldn't that be cool."

The first Performing Under Pressure camp took place in October 2015 for six days. The group of 12 included an e-gamer and some entrepreneurs. The camp included breath-hold exercises, speed racing, bomb disposal, improv

and crawling blindfolded through the interior of a dark wooden box containing pythons. "They came out of those four days with the equivalent of 40 years' life experience," says a Navy Seal psychologist who collaborated with Red Bull. "It was transformational."

Preparing for the unknown was a lesson learned the hard way during Project Stratos. In Project Acheron, it was a feature by design whose effects were later substantiated by scientific evidence. "With the University of San Diego, we measured fMRI pre and post on the athletes," Walshe says. "In many cases, they'd changed their brains to high levels of resilience and adaptability. There are structural changes that accompanied the experience."

The camp divested the challenge of the unknown from its physical manifestation, making it a mostly psychological experience that could be undertaken not only by athletes but performers, musicians and entrepreneurs.

"We learned that the principles we use for an athlete are applicable if you're an entrepreneur, a parent or a scientist," Walshe says. "That's what's behind the idea of hacking talent. I would like to get to a point where we apply the same amount of energy and resources we apply, say, to the world's top football team to the individuals tackling social problems or scientists trying to cure cancer. That's what drives us." 

João Medeiros is WIRED's science editor

[illegible]

Rein



**Where
media
is
going
next**

**By
Kevin
Kelly**

1.

WE ARE IN A PERIOD OF
PRODUCTIVE REMIXING

P

aul Romer, an economist at New York University who specialises in the theory of economic growth, says real sustainable economic growth does not stem from new resources, but from existing ones that are rearranged to make them more valuable. Growth comes from remixing. Brian Arthur, an economist at the Santa Fe Institute who specialises in the dynamics of technological growth, says that all new technologies derive from a combination of existing technologies. Modern technologies are combinations of earlier, primitive technologies that have been rearranged and remixed. Since one can combine hundreds of simpler technologies with hundreds of thousands of more complex technologies, there is an unlimited number of possible new technologies – but they are all remixes. What is true for economic and technological growth is also true for digital growth. We are in a period of productive remixing. Innovators recombine simple earlier media genres with later complex genres to produce an unlimited number of new media genres. The more new genres, the more possible newer ones can be remixed from them. The rate of possible combinations grows exponentially, expanding the culture and the economy.

We live in a golden age of new mediums. In the last several decades, hundreds of media genres have been born, remixed out of old genres. Former mediums such as a newspaper article, or a 30-minute TV sitcom, or a four-minute pop song still persist. But digital technology unbundles those forms into their elements so they can be recombined in new ways. Recent newborn forms include a web list article (a listicle) or a 140-character tweet storm. Some of these recombined forms are now so robust that they serve as a new genre. These new genres themselves will be remixed.

For instance, behind every bestselling book are legions of fans who write their own sequels or fanfic. They may mix elements from more than one book or author. Their chief audience is other avid fans. One fanfic archive lists 1.5 million fan-created works to date.

Extremely short snips of video quickly recorded on a phone can easily be shared and re-shared with the *Vine* app. Six seconds is enough for a joke or a disaster to spread virally. These brief snips may be highly edited for maximum effect. In 2013, 12 million *Vine* clips were posted to Twitter every day and, in 2015, viewers racked up 1.5 billion daily loops. There are stars on *Vine* with a million followers. But there is another kind of video that is even shorter. An animated GIF is a graphic that loops through its small motion again and again and again. The endless repetition encourages it to be studied closely until it transcends into something bigger. These examples can only hint at the outburst and sheer frenzy of new forms appearing in the coming decades. Take any one of these genres and multiply it. Then marry and cross-breed them. We can see the nascent outlines of the new ones that might emerge. With our fingers we will drag objects out of films and remix them into our own photos. A click of our phone camera will capture a landscape, then display its history in words, which we can use to annotate the image. With the coming new tools we'll be able to create our visions on demand.

The supreme fungibility of digital bits allows forms to morph easily, to mutate and hybridise. The quick flow of bits permits one program to emulate another. To simulate another form is a native function of digital media. There's no retreat from this multiplicity. The variety of genres and subgenres will continue to explode. Sure, some will rise in popularity while others wane, but few will disappear entirely. There will still be opera lovers a century from now. But there will be a billion video game fans and a hundred million virtual reality worlds. The accelerating fluidity of bits will continue to overtake media for the next 30 years, furthering a great remixing.





2.

HOLLYWOOD'S MASHUP FUTURE

At the same time, the cheap and universal tools of creation (megapixel phone cameras, *YouTube Capture*, *iMovie*) are quickly reducing the effort needed to create moving images and upsetting a great asymmetry inherent in all media. That is: it is easier to read a book than to write one, easier to listen to a song than to compose one, easier to attend a play than to produce one. Feature-length movies in particular have long suffered from this user asymmetry. A Hollywood blockbuster can take a million person-hours to produce and only two hours to consume. To the utter bafflement of the experts who confidently claimed that viewers would never rise from their reclining passivity, tens of millions of people have in recent years spent uncountable hours making movies of their own design. Having a ready and reachable audience of potential billions helps, as does the choice of multiple modes in which to create. Because of new consumer devices, community training, peer encouragement and fiendishly clever software, the ease of making video now approaches the ease of writing.

This is not how Hollywood makes films. A blockbuster film is a gigantic creature, custom built by hand. Like a Siberian tiger, it demands our attention – but it is also very rare. Every year about 600 feature films are released in North America, or about 1,200 hours of moving images. As a percentage of the hundreds of millions of hours of moving images produced annually today, 1,200 hours is minuscule.

The handcrafted Hollywood film won't go away, but if we want to see the future of motion pictures, we need to study the swarming critters below – the jungle of YouTube, indie films, TV serials, documentaries, commercials, infomercials and insect-scale supercuts and mashups – and not just the tiny apex of tigers. YouTube videos are viewed more than 12 billion times in a single month; some videos have been watched several billion times each, more than any blockbuster movie. Over 100 million short clips with very small audiences are shared to the net every day. Judged merely by volume and the amount of attention the videos collectively garner, these clips are now

We live in a golden age of new mediums.

In the last several decades,
hundreds of media genres have been born,
remixed out of old genres

The vast majority of these non-Hollywood productions rely on remixing, because remixing makes it much easier to create. Amateurs take soundtracks found online, or recorded in their bedrooms, cut and reorder scenes, enter text and then layer in a new story

or novel point of view. Each genre often follows a set format. For example: remixed movie trailers. An unknown amateur may turn a comedy into a horror flick, or vice versa. Some fans create music videos made by matching and mixing a pop song soundtrack with edited clips from obscure cult movies. Or they clip scenes from a favourite movie or movie star, which are then edited to fit an unlikely song. These become music videos for a fantasy universe. Rabid fans of pop bands take their favourite songs on video and add the song's

lyrics in large type. These lyric videos became so popular that some bands have started releasing official music videos with lyrics.

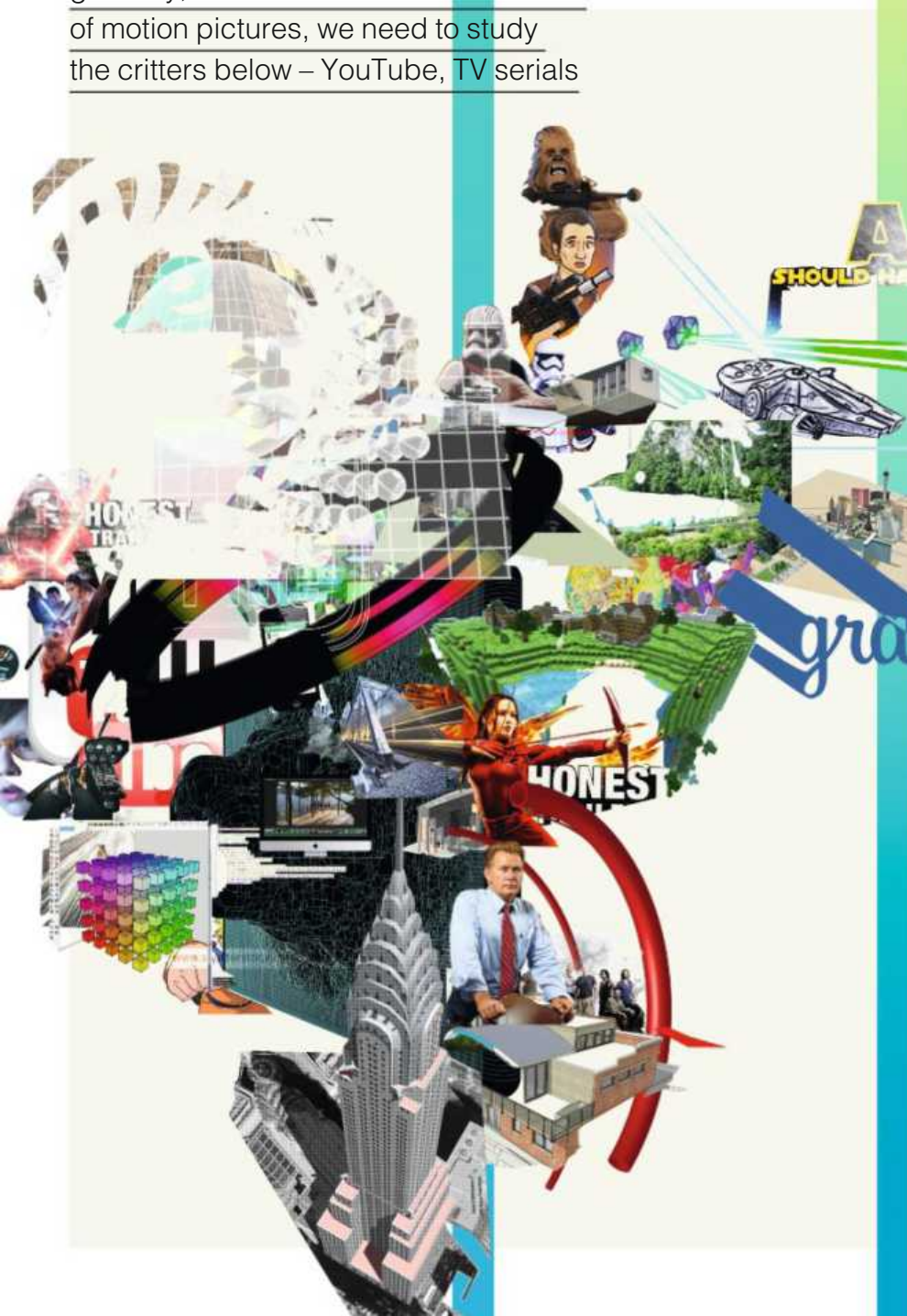
Remixing video can even become a kind of collective sport. Hundreds of thousands of passionate anime fans remix Japanese animations. They clip the cartoons into tiny pieces, some only a few frames long, then rearrange them with video editing software and give them new soundtracks and music, often with English dialogue. The new anime vids tell completely new stories. The real achievement in this subculture is to win the Iron Editor challenge. Just as in the TV cook-off contest *Iron Chef*, the Iron Editor must remix videos in real time in front of an audience while competing with other editors to demonstrate superior visual literacy. The best editors can remix video as fast as you might type.

An image stored on a memory disk instead of celluloid film has a liquidity that allows it to be manipulated as if the picture were words rather than a photo. Hollywood mavericks such as George Lucas embraced digital technology early (Lucas founded Pixar) and pioneered a more fluent way of film-making. In his *Star Wars* films, Lucas devised a method of movie making that has more in common with the way books and paintings are made than with traditional cinematography.

Typically, a film is planned out in scenes; the scenes are filmed (usually more than once); and from a surfeit of these, a movie is assembled. Sometimes a director must go back and shoot “pickup” shots if the final story cannot be told with the available film. With the new screen fluency enabled by digital technology, a movie scene is something more malleable – it is like a writer’s paragraph, constantly being revised. Scenes are not captured (as in a photo) but built up incrementally, like paint, or text. Layers of visual and audio refinement are added over a crude sketch of the motion, the mix constantly in flux, always changeable. George Lucas’s final *Star Wars* movie was layered up in this writerly way, his films were written pixel by pixel.

In the great hive mind of image creation, something similar is already happening with still photographs. Every minute, thousands of photographers are uploading their latest photos to *Instagram*, *Snapchat*, *WhatsApp*, Facebook and Flickr. The more than 1.5 trillion photos posted so far cover any subject you can imagine; I have not yet been able to stump the sites with an image request that cannot be found. Flickr offers more than half a million images of the Golden Gate Bridge alone. If you want to use an image of the bridge, there is really no reason to take a new picture. It's been done. All you need is a really easy way to find it.

The handcrafted Hollywood film won't go away, but if we want to see the future of motion pictures, we need to study the critters below – YouTube, TV serials



3.

THE RISE OF
DATABASE CINEMA

imilar advances have taken place with 3D models. On the archive for 3D models generated in the software SketchUp, you can find insanely detailed three-dimensional virtual models of most major building structures of the world. Need a street in New York? Here's a filmable virtual set. Out of these ready-made "phrases" a film can be assembled, mashed up from available clips or virtual sets.

Media theorist Lev Manovich calls this "database cinema", where component images form a whole new grammar for moving images. It's how authors work. We dip into a database of established words, called a dictionary, and reassemble these found words into articles, novels and poems that no one has ever seen before. The joy is recombining them. What we do now with words, we'll soon do with images.

For directors who speak this new cinematographic language, even the most photorealistic scenes are written over frame by frame. Film-making is thus liberated from the stranglehold of photography. Gone is trying to capture reality with one or two takes of expensive film and then creating your fantasy from whatever you get. Photography exalts the world as it is, whereas this new screen mode, like writing and painting, is engineered to explore the world as it might be.

But merely producing movies with ease is not enough, just as producing books with ease on Gutenberg's press did not fully unleash text. Real literacy also required a long list of innovations and techniques that permitted ordinary readers and writers to manipulate text in ways that made it useful. For instance, quotation symbols make it simple to indicate where one has borrowed text from another writer. We don't have a parallel notation in film yet, but we need one. Once you have a large text document, you need a table of contents to find your way through it. That requires page numbers. Somebody invented them in the 13th century. What is the equivalent in video? Longer texts require an alphabetic index, devised by the Greeks and later developed for libraries of books. With AI we'll have a way to index the full content of a film. Footnotes, invented in the 12th century, allow tangential information to be displayed outside the linear argument of the main text. That would be useful in video. And bibliographic citations (invented in the 13th century) enable scholars and sceptics to systematically consult sources that influence or clarify the content. Imagine a video with citations. These days we have hyperlinks, which connect one piece of text to another, and tags, which categorise using a selected word or phrase for later sorting.

All these permit any literate person to cut and paste ideas, annotate them with her own thoughts, link them to related ideas, search through vast libraries of work, browse subjects quickly, resequence texts, re-find material, remix ideas, quote experts and sample bits of beloved artists. These tools, more than just reading, are the foundations of literacy.

If text literacy meant being able to parse and manipulate texts, then the new media fluency means being able to parse and manipulate moving images with the same ease. But so far, these "reader" tools of visuality have not made their way to the masses. We don't yet have the equivalent of a hyperlink for film. With true screen fluency, I'd be able to cite specific frames of a film or specific items in a frame. Perhaps I am a historian interested in oriental dress, and I want to refer to a fez worn by someone in the movie *Casablanca*. I should be able to refer to the fez itself (and not the head it is on) by linking to its image as the hat "moves" across many frames, just as I can easily link to a printed reference of the fez in text; I'd like to annotate the fez in the film with other film clips of fezzes as references.

With full-blown visuality, I should be able to annotate any object, frame, or scene in a motion picture with any other object, frame, or clip. I should be able to search the visual index of a film, or peruse a visual table of contents,

or scan a visual abstract of its full length. But how do you do all these things? How can we browse a film the way we browse a book?

The first visual literacy tools are already emerging in research labs and on the margins of digital culture. Take, for example, the problem of browsing a feature-length movie. One way to scan a movie would be to super-fast-forward through the two hours in a few minutes. Another way would be to digest it into an abbreviated version in the way a theatrical movie trailer might. Both these methods can compress the time from hours to minutes. But is there a way to reduce the contents of a movie into imagery that could be grasped quickly, as we might see in a table of contents for a book?

Some popular websites with huge selections of movies (such as porn sites) have devised a way for users to scan through the content of full movies quickly in a few seconds. When a user clicks the title frame of a movie, the window skips from one key frame to the next, like a flip-book of the movie. The holy grail of visuality is findability – the ability to search the library of all movies the same way Google can search the web. You want to be able to type key terms, or simply say, "bicycle plus dog", and then retrieve scenes in any film featuring a dog and a bicycle. In an instant you could locate the moment in *The Wizard of Oz* when the witchy Miss Gulch rides off with Toto. Even better, you want to be able to ask Google to find all the other scenes in all movies similar to that scene. That ability is almost here.

Google's cloud AI is gaining visual intelligence rapidly. Give it a picture of a boy riding a motorbike on a dirt road and the AI will label it "boy riding a motorbike on a dirt road". Both Google's and Facebook's AIs can look at a photo and tell you the names of the people in it.

Now, what can be done for one image can also be done for moving images. We'll be able to routinely search video via AI. As we do, we'll begin to explore the Gutenberg possibilities within moving images. "I consider the pixel data in images and video to be the dark matter of the internet," says Fei-Fei Li, director of the Stanford Artificial Intelligence Laboratory. "We are now starting to illuminate it."

As moving images become easier to create, store, annotate and combine into complex narratives, they also become easier to be re-manipulated by the audience. This gives images a liquidity similar to words. Fluid images flow rapidly on to new screens, ready to migrate into new media and seep into the old. Like alphabetic bits, they can be squeezed into links or stretched to fit search engines and databases. Flexible images invite the same satisfying participation in both creation and consumption that the world of text does.

4.

FROM FINDABILITY
TO REWINDABILITY

In addition to findability, another ongoing revolution within media can be considered “rewindability”. In the oral age, when someone spoke, you needed to listen carefully, because once the words were uttered, they were gone. The great shift from oral to written communications gave the audience (readers) the possibility to scroll back to the beginning of a “speech”, by rereading it. One of the revolutionary qualities of books is their ability to repeat themselves for the reader.

In fact, to write a book that is reread is the highest praise for an author. And in many ways authors have exploited this characteristic. They may add plot points that gain meaning on second reading, hide irony that is only revealed on rereading, or pack it full of details that require close study and rereading to decipher. Vladimir Nabokov once claimed, “One cannot read a book: one can only reread it.”

Our screen-based media in the last century had much in common with books. Movies, like books, are narrative driven and linear. But unlike books, movies were rarely rewatched. In the century before videotape, there was no replaying. Television was much the same. A show broadcast on a schedule. You either watched it at the time or you never saw it. Because of this “oral” characteristic, shows were engineered with the assumption they would be seen only once, which forced the narrative to convey as much as possible in the first impression. But it also diminished it, because so much more could be crafted to deliver on second and third encounters.

First VHS, then DVDs, later TiVos and now streaming video make it easy to scroll back screenworks. If you want to see something again, you do. Often. If you want to see only a snippet of a movie or television programme, you do, at any time. This ability to rewind also applies to commercials, news, documentaries, clips – anything online, in fact. More than anything else, rewindability is what has turned commercials into a new art form.

We are now witnessing the same inevitable rewindability of screen-based news. TV news was once an ephemeral stream of stuff that

was never meant to be recorded or analysed – merely inhaled. Now, when we scroll back news, we can compare its veracity, its motives, its assumptions. We can share it, fact-check it, mix it. Because the crowd can rewind what was said earlier, this changes the posture of politicians, of pundits, of anyone making a claim.

The rewindability of film is what makes 120-hour movies such as *Lost*, or *The Wire*, or *Battlestar Galactica* possible and enjoyable. They brim with too many details ingeniously moulded into them to be apparent on initial viewing; scrolling back at any point is essential. Music was transformed when it became recorded, rewindable. The ability to scroll back to the beginning and hear music again – that exact performance – changed music forever. Songs became shorter on average, and more melodic and repeatable.

Games now have scroll-back functions that allow replays, redos, or extra lives, a related concept. All major software packages have an undo button. The complex pieces of consumer software, such as Photoshop or Illustrator, employ what is called nondestructive editing, which means you can rewind to any particular previous point. The genius of Wikipedia is that it also employs nondestructive editing – all previous versions of an article are kept forever. This “redo” function encourages creativity. We are likely to get impatient with experiences that don’t have undo buttons, such as eating a meal. We can’t really replay the taste and smells of a meal. But if we could, that would certainly alter cuisine.

But the perfect replication of media in terms of rewinding is less explored. As we begin to lifelog our daily activities, to capture our live streams, more of our lives will be scrollable. This will shift what we do the first time. The ability to scroll back easily, precisely and deeply might change how we live in the future.

In our near future we’ll have the option to record as much of our conversations as we care to. Some people will record everything as an aid to their memory. The social etiquette around recall will be in flux; private conversations are likely to be off-limits. But more and more of what happens in public will be recorded – and re-viewable – via phone cams, dashboard-mounted webcams on every car and streetlight-mounted surveillance cams. Police will be required by law to record all activity from their wearables. Rewinding police logs will shift public opinion, just as often vindicating police as not.

Rewindability and findability are just two Gutenberg-like transformations that moving images are undergoing. These and many other factors of remixing apply to all newly digitised media, such as VR, music, radio and so on.

5.

TRANSFORMATION
TRUMPS COPYRIGHT



emixing – the rearrangement and reuse of existing pieces – plays havoc with traditional notions of property and ownership. If a melody is a piece of property you own, like your house, then my right to use it without permission or compensation is very limited. But digital bits are closer to ideas than to real estate. How does one “own” a melody? When you give me a melody, you still have it. Yet in what way is it even yours to begin with if it is one note different from a melody a thousand years old? Can one own a note? If you sell me a copy of it, what counts as a copy? What about a backup? These are not esoteric theoretical questions. Music is a multibillion-dollar industry, and the dilemma of what aspect of intangible music can be owned and how it can be remixed is at the front and centre of culture today.

Appropriation of existing material is a venerable and necessary practice. As

“Transformation” is another term for becoming. It acknowledges that the creations we make today will become something else tomorrow. Nothing can remain untouched, unaltered. By that I mean every creation that has any value will eventually and inevitably be transformed – in some version – into something different. Sure, the version of *Harry Potter* that JK Rowling published in 1997 will always be available, but it is inevitable that another thousand fan fiction versions of her book will be penned by avid amateurs. The more powerful the invention or creation, the more likely and more important it is that it will be transformed by others.

This extract was taken from Kevin Kelly's new book, The Inevitable, out now (Viking)

photography: JONATHAN BROWNING

现在你看得见



AS PHOTOGRAPHED BY WIRED

NOW YOU SEE IT

Why would China's version of Google Street View delete a factory, but leave its smoke? Or make a gas tank disappear, but not its signs? WIRED investigates the mystery of Baidu Total View and its bizarre photo editing that creates an entirely new version of reality

by **ROWLAND MANTHORPE**

现在你看不见



AS SEEN ON BAIDU TOTAL VIEW

NOW YOU DON'T



消防站

Fire station

Left // Browning found this fire station in central Shanghai, not far from the popular shopping district of Xintiandi. "That's just next to where I lived," he says. Of all the censored images, it seems the most inexplicable: what reason could there be for concealing the location of a fire station? "Why would they do that?" Browning wonders. "Who's given the directive to make sure these are deleted?"



SHANGHAI

发电厂

Power plant

◀◀ Previous page //

It may be deleted on Total View, but according to Baidu Maps, this is the Shanghai Waigaoqiao Number Three power station. It lies east of Shanghai, beside the outermost ring road. "To get the photo we drove in the slow lane, as the Baidu car would have done, and got the matching shot through the window of our SUV," explains WIRED's photographer Jonathan Browning. "Fortunately, there were no overtaking cars to get in the way of the frame."





污染烟囱

Smoking chimney

Left // The stacks have been removed from the Baidu image, but not the smoke, which billows out regardless. "It's not very well done," says Browning. "The sign has also been Photoshopped so you can't name the power station. Then again, on Map View, it still says which power station it is." This area was busy, so Browning took his photograph from the car. "I got a couple of weird looks, so I did that quickly and then left."



冷却塔

Cooling tower

Left // This cooling tower, with workers relaxing in the foreground, was the first censored image Browning uncovered. "Even 500 to 1,000 metres away on Total View, some parts of it are cloned out. But then if you turn the corner, it's in full view." On the day he took his photographs, this was his penultimate stop. "It's in kind of a no-man's land, so there's not really much going on in that area."



饭馆

Restaurant

Left // The sign outside this building in Baidu's picture reads "restaurant" – bizarrely, the roof of the entranceway has been used as the material for cloning. "I guess with all those plastic bottles there it's an informal recycling depot," says Browning. "Scrap metal, plastics, making a little bit of business." After nine years in China, he still finds the wealth gap bewildering. "You've got these insanely wealthy people, and then you've got places like this."



IN

September 2014, Jonathan Browning came across a Chinese mystery. Browning, a freelance photographer, was searching for locations on Shanghai's Huangpu River using Baidu Total View, the Chinese version of Google Street View. The Huangpu is Shanghai's main river, and large sections of its banks are lined with soot-stained factories and squat industrial compounds. As Browning looked, he saw that one of these structures – a cooling chimney next to a suspension bridge – had been crudely erased. “I thought, that’s strange, why would they do that?” says Browning, 32, who has lived in Shanghai since 2007. “Then I saw another one.” As Browning investigated further, he found other places that had been removed: government buildings, prisons, even a fire station. “At first I thought it could just be for

weird aesthetic reasons,” he says. “I guess it’s security. But it’s a bit random.”

In China, Baidu Maps is the default tool for navigation. Since it launched in 2013, Baidu Total View has covered 372 Chinese cities. As of December 2015, it claimed 302 million monthly active users – up 43 per cent year-on-year.

Baidu Total View was created in the same way as Google Street View: by cars with cameras or – for inaccessible areas – by backpack-toting individuals. Like Google, Baidu removes personal details such as car registration plates. “We respect user privacy and won’t publish any content that infringes on individual privacy and interest, or public security,” says Kaiser Kuo, Baidu’s director of international communications. Kuo declines to answer questions about the missing buildings. But the editing seems to go beyond what is necessary to protect privacy or national security.

“It’s a bit peculiar,” says Johan Lagerkvist, professor of Chinese language and culture at Stockholm University. “It’s like shouting, ‘Hey, we’ve got something secret over here!’”

Rather than national security, the deletions could be an arrangement intended to protect industrial or commercial secrets, says Lagerkvist.

“It doesn’t have to be the government – although that cannot be ruled out.”

To see the blanked-out buildings for himself, Browning hired an SUV and asked a friend to drive him around as he took photographs. “You don’t really want to be seen,” he says. “Two foreigners driving a car is always weird, especially in an industrial area, and then taking photos... It can cause problems.” He’d had awkward confrontations in the past, working on stories about pollution.

Browning wonders about the process behind the censorship: “I don’t know who does it, if it’s an algorithm that gets GPS co-ordinates for each place and then somehow wipes it, or if there’s an actual person that goes to each one and cleans it with Photoshop.” The lack of consistency makes him suspect a human is responsible. “It would be great to meet these people and see what they think about it. If they wanted to do it, why didn’t they do it properly?”

The project was one of Browning’s last in China: after nine years, he moved back to the UK in May with his Chinese wife. “China’s a great country,” he says. “But it’s two different things. You’ve got the government and what they say and do, and then you’ve got the people. The government is always the mystery.”

Rowland Manthorpe is WIRED’s associate editor. He wrote about the co-living phenomenon in 06.16



油气罐

Gas tanks

Left // The blue and white logo in the centre of Browning’s image belongs to the China State Shipbuilding Corporation (CSSC). The bright red Chinese characters to its left read “Waigaoqiao Shipyard”, a subsidiary of CSSC. Browning couldn’t verify whether the gas tanks belonged to CSSC as well, but ownership hardly seems a reason to edit them out. The road led to the shipyard’s gated entrance and car park.



THE MAN WHO OUTRACED HOLLYWOOD

Justin Lin points at the long slender neck of the *Enterprise* on a monitor. It's spindly, that diagonal piece leading up to the saucer section, vulnerable. As a kid, he always wondered, why wouldn't you just attack there?

In a gobsmacking action sequence from *Star Trek Beyond*, directed by Lin, a fleet of ships attacks in a swarm – shredding and slicing the *Enterprise* until it's decapitated. The action feels visceral, painful and scary.

But in the editing bay, Lin is finding problems. He asks to see multiple iterations of the swarm ships: 10,000, 20,000. His team animates the sequence over and over, as Lin adjusts the ships' flight paths. Then he zooms in and critiques the exact locations of tiny thrusters and running lights. He's relentless.

Lin is Hollywood's Racer X: a spectacularly skilled wheelman with a perplexingly low profile that belies his blistering box-office track record. After making his name with the indie hit *Better Luck Tomorrow*, he supercharged the moribund *Fast & Furious* brand into cinema's most inclusive, multibillion-dollar global franchise.

In late 2014, with the 50th anniversary of the *Star Trek* franchise and *Beyond*'s July 22 premiere date looming, Paramount Pictures and producer J.J. Abrams were looking for a new captain, a director known for pushing the pace.

"It was like, hey, this is a rescue mission," says Lin, a trim 44-year-old with a neatly cropped beard and a quiet, confident manner. Over lunch at an outdoor restaurant in downtown LA, he grins wryly: "It was, 'You've got six months.'"

Abrams knew Lin had, as he puts it, "command of a large cast, a great sense of action, a sense of humour," and "an ability to tell stories that would speak to cultures all over the world." Just as important, he knew Lin was fearless – and had an uncanny ability to pull off ambitious shoots with big stars under extreme stress. So he asked Lin to pitch him something bold. Lin told Abrams he wanted to destroy the *Enterprise*.

Still, Lin had to think carefully before taking the big chair. The sci-fi blockbuster would have to get from script to special effects at warp speed. And Lin had just turned down the most lucrative offer of his life – to direct *Furious 7* – partly because of a similarly rushed shoot, but mostly to prove he was more than just a franchise doctor.

In between *Fast* films, the mogul-in-the-making has shown he can drive anything from comedies (Lin directed the *Community* episode Dan Harmon calls "our biggest triumph" – the first season's paintball odyssey, "Modern Warfare"), to hit network dramas (the pilot of *Scorpion*, which he produces through his company Perfect Storm). When Abrams offered him *Trek*, Lin had just launched a content studio, Bullitt, specialising in VR, with directors Joe and Anthony Russo (*Captain America: Civil War*), and, in conjunction with Google, had shot the 360-degree interactive monster movie *Help*. Lin was also directing two episodes of *True Detective* season two – even as he was lining up his own fresh take on *Space Jam*.

But this was *Star Trek*. Lin kept thinking of how, when he was a child, his father would come home from his 12-hour workdays and the two would watch reruns of TV's most trailblazingly diverse show – one of the only to feature an Asian American actor (George Takei).

Lin drove to his parents' house. "I just remember looking at them and thinking, 'I should do it.'"

He supercharged the *Fast* and *Furious* franchise and gave it global appeal. Now he's about to soup up *Star Trek*. How Justin Lin's high-octane, diversity-fuelled vision will help drag Tinseltown into the 21st century

By
Logan
Hill

PHOTOGRAPHY:
FRANK OCKENFELS 3



1. The paintball battle in *Community's* "Modern Warfare" episode (2010)

Lin turned Greendale Community College into a paintball-splattered war zone in this witty, full-throttle episode. "Just 22 minutes but feels like 90," show creator Dan Harmon says. "Like a little movie"

EARLY ON A

crisp February morning, over a breakfast of egg whites and oatmeal

at the deli in a low-key grocery store near his editing room in Pasadena, California, Lin tells WIRED about his *Trek* pitch. Instead of recycling old enemies (as in the controversial yet wildly successful *Star Trek Into Darkness*), he wanted to take away every familiar comfort of Starfleet, the bridge and the recent films to "make the characters as raw as possible," Lin says, "and build them back up." He wanted to refocus the franchise on how the crew would react as underdogs, in an unfamiliar world, facing unknown enemies.

It sounds a bit like the immigrant biography of Lin, who learned to hustle by watching his parents start over in a new country. He spent his early childhood on a family farm in Taiwan, where he remembers that his father, an airline pilot, would bike three hours to work to save money on the commute. When he was eight, the Lins invested their life savings in a fish and chip shop in Anaheim, California, and moved to nearby Buena Park, where they worked nonstop, overstayed their visas, and lived in fear of deportation until President Reagan's Immigration Reform and Control Act granted them amnesty in 1987.

In that greasy shop in the shadow of Disneyland, Lin saw the way customers either respected his father, his hero, or regarded him as "just an Asian immigrant, and they'd treat him like shit". One night, a violent customer called Lin a "fucking Chink" and shattered the shop's glass door with a punch – at a time when any repair was a precious expense. His father worked 364 days a year, taking only Thanksgiving off.

Unable to speak English, Lin was sent to the Boys Club of Buena Park, where Coach Bob tapped him and his younger brother, John – the only Asian kids – for the basketball team. They sat on the bench, but in the season's last blowout Lin only played junk minutes but still managed to make one shot.

"It changed my life," he says, grinning.

At the library, Lin learned English by reading biographies of famous Lakers. At the playground, he learned that, in America, even assholes respect you when you put points on the board. A bully called him "fag" and "gook" every day – until Lin beat him at a game of one-on-one.

Lin – 5'2" in fifth grade, 5'4" today – played centre, then forward, then point guard in high school. He grew up wanting to be a playmaker like his idol, Magic Johnson, after whom he would name his

first film company, Trailing Johnson.

Off the court, wearing much-mocked bowling shoes from Goodwill, he also wanted to prove himself. He envied his neighbours, the Klug brothers, who had "a trampoline and all the Hot Wheels cars I couldn't afford". So one day, like a pint-size version of Vin Diesel's Dominic Toretto, he stole a little toy car from a store – and got caught by his brother, who called their dad.

After that, Lin started making knockoff cars out of tinfoil. One day in the garage, he built a ramp out of scrap wood and drew a chequered flag with a Sharpie. "Ray Klug goes, 'I'll give you three cars for that,'" Lin recalls. They weren't great cars – one was a garbage truck – but when he looks back at his career now, "it all goes back to that ramp," Lin says. "I realised I could create things and people might actually want them."

Today, when that kid who couldn't afford toy cars walks out to the parking lot, he unlocks a preposterously beautiful black Aston Martin Rapide. "I think it's the only one with a car seat," he says, shrugging as he points to the seat in the back of the family car for his six-year-old son, Oqwe.

For Lin, *Star Trek Beyond* will be a chance to remind people that there's more to him than car chases – and that the global appeal of his *Fast* franchise was earned honestly, not cynically.

Lin's rise comes at a critical moment in Hollywood: just as the global marketplace is becoming more important than the American audience, the industry's systemic discrimination has never been more painfully obvious, from #OscarsSoWhite protests to the US

Equal Employment Opportunity

Commission's investigation into gender discrimination among directors. Lin worries that Hollywood these days sees diversity as a fad. "A casting

director told me every person of colour she works with is being cast this year in pilot season," Lin says. "But I've been in this business long enough to know there are ups and downs." While woefully out-of-touch film-makers have shamelessly pandered, pairing white stars with token minorities, Lin has been a genuinely inclusive pioneer, bringing the cocksure diversity of his scrappy indie films to the multiplex.

As a kid, he saw just two films in a cinema – *E.T.* and *Rocky III*. But two

Star Trek Beyond will be a chance for Lin to remind people there's more to him than car chases

movie rentals led him to UCLA's film school: Francis Ford Coppola's *Tucker* blew his mind, and *Do the Right Thing* made him angry in a way he didn't understand. When Spike Lee's *Mookie* threw that garbage can through the window of Sal's mom-and-pop pizzeria, "I was just shaking, I was so pissed," he says, thinking of his father's store. As he grasped the full power of the film, "it unlocked something in me".

Lin became determined to tell his own stories. His first co-directed film, 1997's *Shopping for Fangs*, was an offbeat Asian American SoCal werewolf tale made for about \$80,000 (£55,000) and notable as the first screen credit of *Star Trek Beyond*'s Sulu, John Cho. Roger Ebert showed up to a festival screening - but left before the end.

For his solo debut, 2002's *Better Luck Tomorrow*, Lin needed \$250,000, a small but impossible sum. One financier offered him \$2 million - if he replaced his Asian American lead with Macaulay Culkin. Lin said no, racked up \$100,000 on credit cards and, in the end, was saved by a crucial \$6,500 investment from MC Hammer, whom Lin randomly met at a broadcasting convention.

Growing up in the 80s, Lin endured a barrage of racist references to the

Indiana Jones sidekick Short Round or *Sixteen Candles*' sexless goofball Long Duk Dong. *Better Luck Tomorrow* blasted past such stereotyping: it was a coming-of-age crime tale about straight-A Asian American teens who ditch the model-minority myth and sell test scores, then drugs, while partying and snorting more coke than Charlie Sheen. He cast Parry Shen as the basketball-obsessed good kid gone bad, John Cho as the unhappy rich kid and Sung Kang as the effortless stud Han.

"It was daring even in the Asian American community," says Cho, noting that the film flew in the face of respectable family melodramas such as *The Joy Luck Club*. "This was youth-oriented and breaking a lot of rules about how Asians were supposed to present ourselves to the world."

Cut to the 2002 Sundance Film Festival: the premiere kills. The movie is stylish and brash, and nobody knows how to sell it. Fox Searchlight execs worry it will set a bad example for Asian American teens and suggest Lin add a moralistic, crime-doesn't-pay ending. A Paramount Classics executive is utterly dismissive, trashing the film in front of Lin and saying "over my dead body" will the studio touch it.

2. The 360° monster rampage in *Help* (2015)

Lin went big with a blockbuster-calibre 360° interactive alien assault, in which a nasty little monster suddenly supersedes, then rips up downtown Los Angeles



**THEN ROGER
EBERT STANDS
UP AND
SHOUTS:
'NOBODY
WOULD SAY
THAT
TO WHITE
FILM-MAKERS'**



3. Rio heist in *Fast Five* (2011)

In this indelible sequence, thieves in two Dodge Chargers with cables attached yank a massive vault out of a police station. The cars speed through the streets of Rio, dragging the vault, causing catastrophic – and entertaining – damage as they make their getaway



At a Q&A after a midnight screening, an older guy accuses *Better Luck Tomorrow* of being “empty and amoral” – but Roger Ebert (who stayed till the end this time) stands up and shouts, “Nobody would say that to a bunch of white film-makers: ‘How could you do this to your people?’ Asian American characters have the right to be whoever the hell they want to be!”

Ebert dubbed the movie a “coming-of-age film for Asian Americans in American cinema”. He went on: “Lin is making a movie where race is not the point but simply the given.” MTV Films bought it. Then, months later, Sherry Lansing, head of parent studio Paramount, called Lin into her office with good news. She wanted to release it through her prestige division, Paramount Classics.

Lin refused. He told Lansing there was no way the film could be released by the executive who had dismissed it. “If it fails, I don’t want to feel like it’s because she hates the movie,” he said. “And if it succeeds, I don’t want to contribute to her career.”

The tiny film was released under the big Paramount logo, just as *Star Trek Beyond* will be, and grossed a very profitable \$3.8 million: Lin had sunk his first basket in Hollywood. He’d put numbers on the board.

LIN'S

Aston Martin rumbles to a halt outside a nondescript brick building in Pasadena. He set up his office just two minutes from home to save time. Lin takes meetings over meals, says he sleeps very little and wears variations on the same uniform every day, like he’s in Starfleet: functional grey technical pants, a long-sleeve white sport shirt, pristine white Nike Air Force Ones.

The office is Lin’s court. He aspires to be a visionary leader like Magic, dishing to his creative team, which eats communal meals and takes play seriously: in the common area, there’s a foosball table – and, on the wall, an elaborate double-elimination, seeded

tournament bracket. Lin even invented his own complex, salary-capped fantasy basketball league, which lured in Lakers vet Rick Fox and sports columnist and analyst Bill Simmons, who calls it “the greatest fantasy league ever created”.

Lin’s production team took him a decade to build. “People I work with are part of my family now: I feel like that’s the new sense of family around the world.”

Family, of course, is the tagline, theme and throbbing backbeat of the *Fast* franchise, which Lin saved from the junkyard. *The Fast and the Furious* (with Vin Diesel, Paul Walker, Michelle Rodriguez and Jordana Brewster) in 2001 and its horrifically titled 2003 sequel, *2 Fast 2 Furious*, were \$200 million hits, made on the cheap. But Universal wanted to go even cheaper. When Lin was offered the third *Fast* film in 2005, the offer came without any stars: Diesel, Walker, Rodriguez and Brewster were all gone.

“The franchise was at a point where we were talking about going direct to video,” former Universal executive Jeff Kirschenbaum says. Lin first turned it down because the script, set in Japan, included clichés such as geishas with white studs.

Instead, Lin pitched a fresh vision of a Tokyo that was defined more by familiarity than difference: a global youth culture united by hip hop, street fashion and speed. The studio gave Lin just two months to prep, but he delivered an under-budget action film with spectacular stunt work: beautiful shots of import cars speeding and gliding through parking lots. Instead of pandering with tokenism, Lin flexed his natural feel for diversity –

and brought back Sung Kang’s Han, *Better Luck Tomorrow*’s understated, handsome rebuke to Hollywood’s racist Asian retinue of inscrutable villains and sexless sidekicks.

Lin screened a rough cut for Vin Diesel, who agreed to a cameo, promising a reboot if it went well. *The Fast and the Furious: Tokyo Drift* earned \$62 million domestically and \$95 million globally: the first film of the franchise to earn more abroad than at home, proof of Lin’s international vision.

“Justin’s the transformer,” Rodriguez says. “He’s the one who got together with Vin and said, ‘We can turn this into something powerful.’”

Though cast and crew freely admit that *Fast* scripts are often written on the fly, Lin took the franchise seriously. He topped his own stunts every time, from spectacular train heists and tumbling tank flips in the Dominican Republic and Spain to a wild race through Rio, with two muscle cars tethered to a giant safe. Lin and Diesel also gave the films a singular, propulsive sense of mission: inclusion.

Before Lin took over, the first two films pitted ethnic clubs against each other. “It was separate families: the Mexican crew, the homeboy crew,” says Diesel, whose production company is called One Race Films. “You didn’t see a multicultural family. The idea that Dom’s brothers are Han and Brian and Roman and Santos – that’s a pretty intense idea.” The franchise takes on “the lack of diversity in Hollywood with a grin and a popcorn smile,” Rodriguez says.

Under Lin’s guidance, the franchise leapt from \$158 million (*Tokyo Drift*) to \$363 million (*Fast & Furious*), then \$626 million (*Fast Five*) and \$789 million (*Fast & Furious 6*). After *Furious 7*, directed by James Wan, earned \$1.52 billion, Universal green-lit three more.

“I’m going to bring him back,” Diesel says, when asked if Lin will direct the finale. “Whenever we had a day off – even on Thanksgiving, his favourite holiday – it was Justin and me working on how far we could take it. Success comes from ten years of that mentality.”

Lin, who says he works Thanksgivings because he’s thankful that his father only ever took that one day off, laughs when WIRED asks him if it’s true. “Vin says that you finish what you started,” he says. “And he’s very persuasive.”



On the *Beyond* set, Lin shot all day and spent all night in the editing bay, Cho says, assembling a cut on the fly. “At some point, it becomes like a psychological problem. Have a glass of wine with us!”

This is why Lin was hurt when some fans – including the original Sulu, George Takei, who voice-acted on Lin’s Bruce Lee mockumentary, *Finishing the Game* – bashed the 30-second *Star Trek Beyond* teaser that leaked a year ago. Some complained it looked like *Fast & Furious in Space* because Chris Pine’s Captain Kirk jumps a motorcycle (even though Pine also rode a motorcycle in Abrams’ 2009 reboot trailer). “George has always handled things with class,” Lin says. “He was a huge part of my life, so for him to swing a sucker punch, that hurt.”

He expected snark. He just didn’t expect it to sting. “On *Fast*, I wasn’t a car guy,” Lin says. “It hurt more because this is a part of me.”

His co-writer, Simon Pegg, is less diplomatic. Pegg says he was “disappointed that Wil Wheaton, Patton Oswalt and George Takei were slagging off the trailer, because they know a finished trailer is never a reflection of the finished film. Get a fucking clue!”

In preproduction, Lin was constructing sets – and worlds – while Pegg and another writer, Doug Jung, were simultaneously working on the script. For his part, Lin says he’s learned to tune in to all that buzzer-beating pressure, so that stressful urgency bleeds into the film itself.

“I always end up in these volatile situations,” he says. “It’s funny. They say people with lower heart rates tend to be criminals – that’s how they get that jolt of adrenaline. The joke is that my heart rate is really low, and this” – he gestures at the frenzy of the office – “is how I stay alive.”

Even as he’s wrapping *Star Trek*, he’s mapping out his next moves. His whiteboard is marked up with character arcs for Daffy Duck and Bugs Bunny in the new *Space Jam*, which Lin is giddily excited about writing, not least because they’re in talks with LeBron James.

On his dinner break from *Star Trek*, he packs in an ideas meeting with his production team. Last year, Lin co-produced *Hollywood Adventures*, an American action comedy about Chinese tourists in LA, created for a Chinese audience. Now the team has set up a comedy with Jeremy Renner at HBO, a Bruce Lee-themed series at Cinemax, and they’re developing the classic samurai graphic novel *Lone Wolf and Cub*.

Lin also checks in on the witty Asian American pop culture website he co-produces, YOMYOMF (You Offend Me, You Offend My Family), which takes on everything from NBA star Yao Ming to Sikh army officers, and sponsors short-film contests for young film-makers. Lin doesn’t beat the drum for inclusion, but he’s embracing the fact that, at 44, he’s a Hollywood player.

Next, Lin could direct more and bigger blockbusters, more TV, or a controversial drama he’s developing, or he could focus on his passion project, *32 Miles*, a coming-of-age film he’s writing about a young Asian kid,

obsessed with Magic Johnson, who faces his greatest fear – being left alone in Los Angeles without his parents.

Whatever Lin chooses, he says he’s determined to make the most of the opportunities his family created for him. “Film is similar to a basketball game,” he says. “When that buzzer sounds, win or lose, the only thing you can control is how much effort you put into it.” In Hollywood, the playing field is hardly level. But like his hero Magic, Lin works hard to create his own shots – and he’s determined to leave it all on the floor. ■

Lin wants the buzzer-beating urgency of movie production to bleed into the film itself

Logan Hill is a freelance arts and culture writer based in Harlem in New York

WIRED

10 PRINT ISSUES + 10 DIGITAL ISSUES = PAY ONLY £28



**FREE
GIFT***
RRP £31.87



© &™ Lucasfilm Ltd.

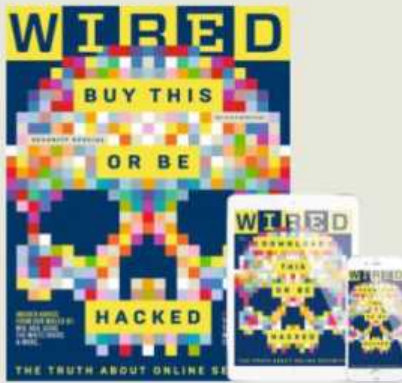
FREE STAR WARS™ 16GB USB DRIVES FROM TRIBE*

Subscribe to Wired and join the Light Side with these BB-8 and Rey 16GB USB drives by Tribe! Celebrate Star Wars™: The Force Awakens and bring your favourite characters and data wherever you go. Tribe makes high-quality tech accessories that bring the best of pop culture to your personal tech collection. Visit www.tribe-tech.com

SUBSCRIBE TO RECEIVE PRINT COPIES AND ENJOY FREE AND INSTANT ACCESS TO IPAD AND IPHONE EDITIONS. ALL YOU NEED IS YOUR SUBSCRIPTION NUMBER.

WIRED.CO.UK/SUBS/CWR15813
0844 848 5202 REF: CWR15813

*LIMITED TO UK ADDRESSES. ANNUAL SUBSCRIPTION TO WIRED INCLUDES 10 PRINT ISSUES & 10 DIGITAL EDITIONS. GIFT IS SUBJECT TO AVAILABILITY AND WILL BE SENT TO THE DONOR. OFFER CLOSES ON 09/08/2016.



04.16 BUY THIS OR BE HACKED – THE TRUTH ABOUT ONLINE SECURITY



03.16 IT'S TIME TO COPY CHINA – WHAT YOU CAN LEARN FROM ITS MOST INVENTIVE STAFF



02.16 THE FUTURE OF FOOD – FEATURING NOMA'S RENÉ REDZEPÍ



01.16 STAR WARS – J.J. ABRAM ON REBOOTING AN ENTIRE UNIVERSE



12.15 PIXAR AND THE NEW RULES OF BUSINESS CREATIVITY



11.15 FACEBOOK'S APP FOR EVERYTHING



10.15 OLAFUR ELIASSON'S CREATIVE MANIFESTO



09.15 THE 2015 WIRED 100 ISSUE: THE BIGGEST HITTERS IN THE WIRED WORLD



08.15 PRODUCT SPECIAL: EVERYTHING YOU NEED TO LIVE THE WIRED LIFE



07.15 INSIDE GOOGLE'S SECRET ARTIFICIAL INTELLIGENCE PROJECT



06.15 ÜBER – 41 LESSONS FROM A \$40BN PHENOMENON



05.15 HOW DATA SAVED MUSIC – INSIDE KOBALT

CLARIFICATION

In 06.16, 3 Million Club's Chamutal Eitam incorrectly claims that 0.14¢ of every dollar given to Save the Children (StC) goes to a child in need. The actual amount is 88p per £1 which, according to StC, goes "on activities to benefit children, 11p to raise the next £1 and 1p on governance".

Please pitch stories to editorial @wired.co.uk
PRs contact us at pr@wired.co.uk
Send feedback to rants@wired.co.uk



BATCAVES THIS MONTH

No WIRED product special can be truly complete without a LEGO set – and this year we had a whopper in the form of the Classic TV Series Batcave. As with everything we feature, it was thoroughly tested by a specialist – here, our chief sub-editor is pictured spending his Saturday in the WIRED office on a super-heroic eight-hour build (he's putting the Batcopter together, FYI). His personal highlight? The Batpoles in the Wayne Manor library. Download the WIRED app to watch a start-to-finish timelapse.

OVERHEARD
AT WIRED
THIS MONTH

"It's all looking very sophisticated and classy. What we need is a gigantic Batcave made of LEGO, smack in the middle."

"The word 'data' is everywhere now."

"I can't help feeling that we are in some way responsible."

"Sometimes, I intentionally send out emails with typos in them, just to show how busy I am."

"Two men trying to fight while wearing cycling shoes."

That's never going to look like an impressive thing."

GRATITUDE
THIS MONTH

Huge thanks to Kati Jagger and Rapha for creating the custom-printed Rapha cycling shirt that bears the title and credits for our Team Sky feature.

THE COLOPHON

IN THE USA:

Condé Nast
Chairman Emeritus:
S.I. Newhouse, Jr.
Chairman:
Charles H. Townsend
President and Chief
Executive Officer:
Robert A. Sauerberg, Jr.
Artistic Director:
Anna Wintour

IN OTHER COUNTRIES:

Condé Nast International
Chairman and Chief
Executive:
Jonathan Newhouse
President:
Nicholas Coleridge
Vice Presidents:
Giampaolo Grandi,
Moritz von Laffert,
Elizabeth Schimel
Chief Digital Officer:
Wolfgang Blau
President, Asia-Pacific:
James Woolhouse
President, New Markets
and Editorial Director,
Brand Development:
Karina Dobrotvorskaya
Director of Planning:
Jason Miles
Director of Acquisitions
and Investments:
Moritz von Laffert

GLOBAL:
President, Condé Nast
E-commerce:
Franck Zayan
Executive Director,
Condé Nast Global
Development:
Jamie Bill

THE CONDÉ NAST
GROUP OF BRANDS
INCLUDES:

US

Vogue, Vanity Fair,
Glamour, Brides, Self,
GQ, GQ Style, The
New Yorker, Condé
Nast Traveler, Allure,
Architectural Digest,
Bon Appétit, Epicurious,
Wired, W, Golf Digest,
Teen Vogue, Ars
Technica, Condé Nast
Entertainment, The
Scene, Pitchfork

UK

Vogue, House & Garden,
Brides, Tatler, The
World of Interiors, GQ,
Vanity Fair, Condé Nast
Traveller, Glamour,
Condé Nast Johansens,
GQ Style, Love, Wired,
Condé Nast College of
Fashion & Design,
Ars Technica

France

Vogue, Vogue Hommes
International, AD,
Glamour, Vogue
Collections, GQ,
AD Collector, Vanity Fair,
Vogue Travel in France,
GQ Le Manuel du Style,
Glamour Style

Italy

Vogue, L'Uomo
Vogue, Vogue
Bambini, Glamour,
Vogue Sposa, AD,
Condé Nast Traveller,
GQ, Vanity Fair, Wired,
Vogue Accessory, La
Cucina Italiana, CNLive

Germany

Vogue, GQ, AD, Glamour,
GQ Style, Myself, Wired

Spain

Vogue, GQ, Vogue
Novias, Vogue Niños,
Condé Nast Traveler,
Vogue Colecciones,
Vogue Belleza,
Glamour, AD, Vanity Fair

Japan

Vogue, GQ, Vogue Girl,
Wired, Vogue Wedding

Taiwan

Vogue, GQ

Mexico and Latin
America

Vogue Mexico and
Latin America,
Glamour Mexico
and Latin America,
AD Mexico,
GQ Mexico and
Latin America, Vanity
Fair Mexico

India

Vogue, GQ, Condé Nast
Traveller, AD

PUBLISHED UNDER
JOINT VENTURE:

Brazil

Vogue, Casa Vogue,
GQ, Glamour, GQ Style

Russia

Vogue, GQ, AD,
Glamour, GQ Style,
Tatler, Condé Nast
Traveller, Allure

PUBLISHED
UNDER LICENSE
OR COPYRIGHT
COOPERATION:

Australia

Vogue, Vogue Living, GQ

Bulgaria

Glamour

China

Vogue, Vogue
Collections, Self, AD,
Condé Nast Traveler,
GQ, GQ Style, Brides,
Condé Nast Center of
Fashion & Design

Czech Republic
and Slovakia

La Cucina Italiana

Hungary
Glamour

Iceland

Glamour

Korea

Vogue, GQ, Allure,
W, GQ Style

Middle East

Condé Nast Traveller,
AD, Vogue Café
at The Dubai Mall,
GQ Bar Dubai

Poland

Glamour

Portugal

Vogue, GQ

Romania

Glamour

Russia

Vogue Café Moscow,
Tatler Club Moscow

South Africa

House & Garden, GQ,
Glamour, House & Garden
Gourmet, GQ Style

The Netherlands

Glamour, Vogue

Thailand

Vogue, GQ,

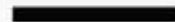
Vogue Lounge Bangkok

Turkey

Vogue, GQ, Condé
Nast Traveller, La
Cucina Italiana, GQ
Style, Glamour

Ukraine

Vogue, Vogue Café Kiev



Recycle this magazine

Caffe Biscardi



For **Caffe Biscardi 1903**, coffee is an art mastered over three generations on a journey that started in New York in 1903. Biscardi's unique blends are crafted in Naples following the secret recipes prepared by Nonno Ferdinando utilising only the best beans roasted on a fire fed with hand-chopped oak wood. Discover their story and taste their signature blends Brooklyn, Vesuvio and 1903 at www.caffebiscardi1903.com or email info@caffebiscardi1903.com

Wasatch



Wasatch Outdoors was founded by three friends with the goal of creation, innovation, and entrepreneurship. Each of the models come with 550 paracord as well as a fire starting tinder strand (from Live Fire Gear, LLC) in the core. It's the survival kit that follows you everywhere! Find their full range at www.wasatchoutdoors.com Survival Lace 2.0, \$17.99

Vintage Watch Movement Cufflinks- By Pretty Eccentric.

Swiss jewelled watch movements from the 1920s - 1950s. Backed with vintage leather and mounted as cufflinks. Presented in vintage inspired box, £49 .



Visit www.prettyeccentric.co.uk or call 07870607925.

KitSound



When one passive bass radiator isn't enough, have two: the **KitSound** Hive Evolution has a pair to ensure perfect acoustic balance. Combined with 20 Watts of power, this monocoque aluminium chassis ensures the weight is equally distributed, making this speaker durable and robust, ready for whatever life throws at it. Buy online from Amazon or instores from Dixons Travel RRP £129.99 Learn more at www.kitsound.co.uk

Floatti



Floatti is the best of both Worlds. Travel in style with this companion; which integrates a design framework drawing inspiration from the beauties of a classic suitcase along with up to the minute technology built into their 7 features offering stress-free traveling. Visit www.floatti.com

Punkt



Punkt. UC 01: USB charging just got easier. And faster. The Italian-made UC 01 designed by Jasper Morrison is a brilliant solution for mobile device charging. At 2.5A per port, the UC 01 is the most powerful 3-way USB multi-charger out there and can recharge three iPads at once. www.punkt.ch

Rigg



At their factory in Birmingham, **Rigg** make great furniture for domestic and commercial clients. Featured is their Grafik desk which is available in a range of sizes. Other items in their range include dining and coffee tables. Delivery is free to most UK places. Visit www.rigg.uk or call 0800 651 0001.

Mopbike



This Urban e-bike from **Mopbike** is handmade in Italy and allows you to control the power output via smartphone. Order now at www.mopbike.com or email info@mopbike.com for more information.

RIVIR



RIVIR is a unique and sophisticated shaving company for the modern man.

They offer handcrafted aluminium handles made in the UK, along with a convenient and affordable shaving subscription from just £5 per month.

To order yours now, visit www.rivir.co.uk

Essential Dark Hours Watch by Greyhours

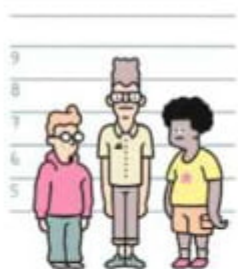
Greyhours is a new brand creating ambitious watches by taking advantage of exclusive materials commonly used for the manufacture of high-end timepieces.

The 9.10mm thick Essential Black DLC featured here is their first model, £150.

Visit www.greyhours.com or email sales@greyhours.com for further information.

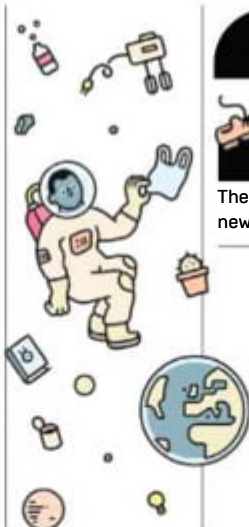


THE WIRED INDEX



96%

The accuracy with which a Princeton University study was able to identify programmers from their coding style: syntactical features survive compilation



200

The mean number, per year, of objects newly detected by Nasa in the Earth's orbit

7,355

Number of patents filed by IBM in 2015. It has now filed the most patents for a record 23 years in a row

ONE

Number of operational nuclear plants in Japan, after the shutdown of the Takahama plant in March

75%

Proportion of global payments made in cash, 2015

1 TRILLION

Distance, in km, between the Earth and the largest known solar system. 2MASS J2126-8140 and its star, TYC 9486-927-1, were found in January

245,000

Number of mutant mosquitoes released every day for the last ten months by the Brazilian company Oxitec to fight the Zika virus. According to Oxitec, the insects, which pass a lethal gene to their offspring, have helped reduce the mosquito population by 82 per cent

25%

Proportion of Swedish payments made in cash, 2015

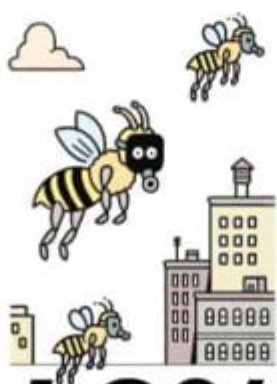
79%

The proportion of Chinese startups that have at least one woman in the company's leadership, out of more than 900 companies surveyed



20

Percentage of JPMorgan Chase employees who clicked on a fake phishing email sent to test them



40%

Proportion of invertebrate pollinators, especially bees and butterflies, which face extinction because of factors such as pesticides, parasites and habitat loss, according to a UN report

5M

Number of units sold worldwide of Google's VR goggles, Cardboard, in its first 19 months

ERROR 451

A recently created HTTP code to signify online censorship, honouring Ray Bradbury's dystopian novel *Fahrenheit 451*

Stay ahead of the
competition with
WIRED Consulting



Immersive sessions for senior leadership teams
Access to the people building the future
Curated events designed to transform your business

WIRED Consulting creates bespoke programmes
for corporate clients. Let us know your needs

consulting@wired.co.uk

THE EXPLORER II

Built to accompany intrepid explorers,
engineered for adventures to extreme frontiers.
It doesn't just tell time. It tells history.



OYSTER PERPETUAL EXPLORER II


ROLEX

Please turn the page to view Supplement

WIRED

TIME



A FREE 52-PAGE
SUPPLEMENT
WITH WIRED
JULY/AUGUST 2016



Big Pilot's Watch. Ref. 5009: The world is like a book you understand better with the knowledge of the well-travelled cosmopolitan. Because the greater your experience, the more likely it is to reveal its complexity within the context of time. Seen from this perspective, it is soon obvious where the watch-making roots of IWC's new Big Pilot's Watch lie: in the glorious early days of the Pilot's Watch era at IWC. After all, it is the legitimate successor of a genuine original, of the first observer's watch made by the Schaffhausen-based company: the Big Pilot's Watch

52 T. S. C. For this was the timepiece that heralded the illustrious decade of the Big Pilot's Watches at IWC and still stands as a milestone in pilot's watch history. Following this tradition, the latest model has the same absolute precision and a starkly reduced dial design recalling the clarity of the cockpit instruments in legendary aircraft like the Junkers Ju 52 from the infancy of aviation. All in all, the current Big Pilot's Watch is the latest original in the history of IWC's Pilot's Watches and at the same time a mirror reflecting its illustrious past. **IWC. ENGINEERED FOR MEN.**

JOIN THE CONVERSATION: #B_ORIGINAL

IWC SCHAFFHAUSEN BOUTIQUES: PARIS | LONDON | ROME | MOSCOW | NEW YORK | BEIJING | DUBAI | HONG KONG | GENEVA | ZURICH
IWC.COM

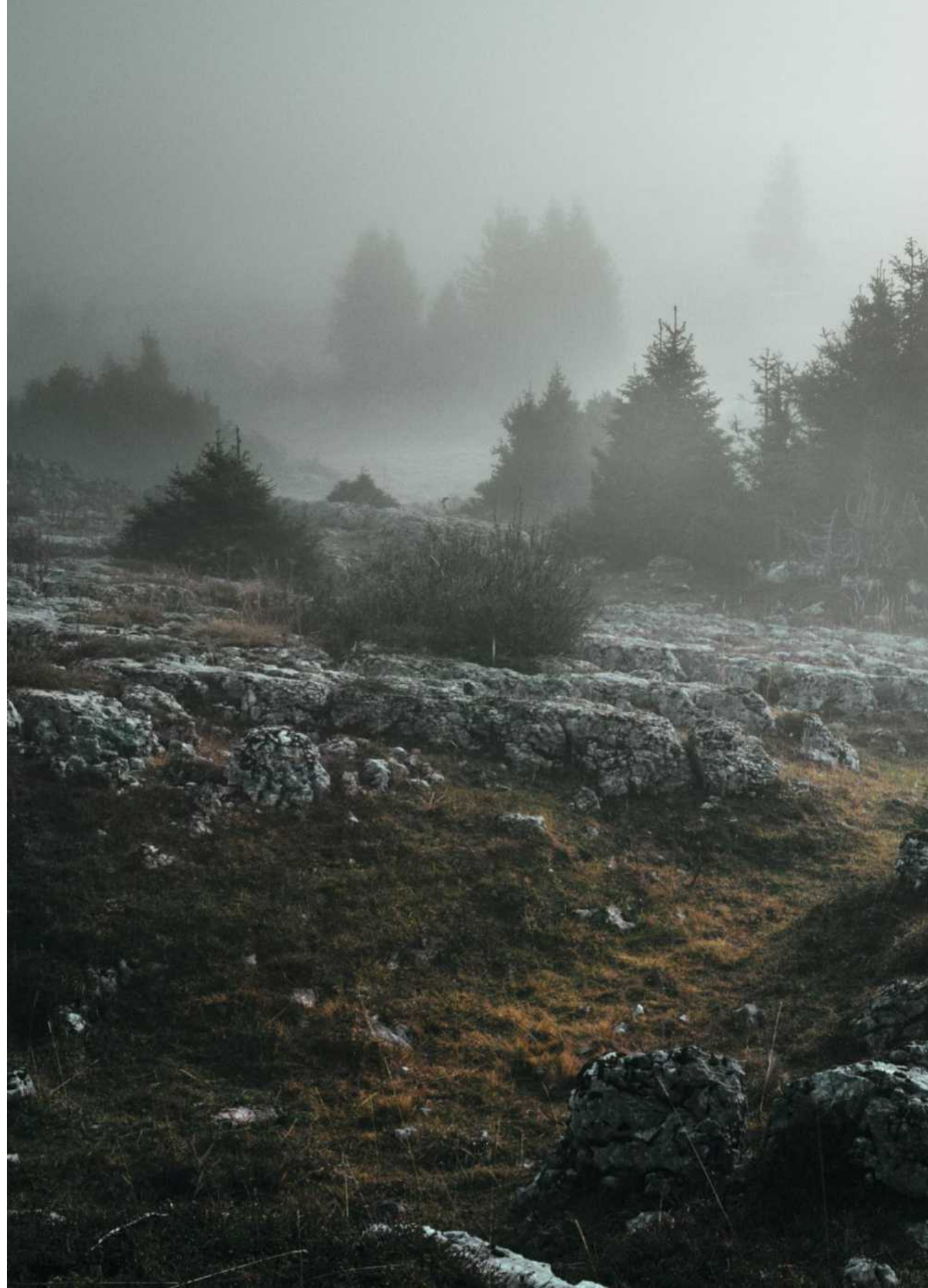
London Boutique | 138 New Bond Street | W1S 2TJ | +44 (0) 203 618 3900 | www.iwc.com

**ENGINEERED FOR MEN
WHO SEE THE WORLD AS
A REFLECTION OF TIME.**



IWC
SCHAFFHAUSEN





TO BREAK THE RULES,
YOU MUST FIRST MASTER
THEM.

THE VALLÉE DE JOUX. FOR MILLENNIA A HARSH,
UNYIELDING ENVIRONMENT; AND SINCE 1875 THE
HOME OF AUDEMARS PIGUET, IN THE VILLAGE OF
LE BRASSUS. THE EARLY WATCHMAKERS WERE
SHAPED HERE, IN AWE OF THE FORCE OF NATURE
YET DRIVEN TO MASTER ITS MYSTERIES THROUGH
THE COMPLEX MECHANICS OF THEIR CRAFT. STILL
TODAY THIS PIONEERING SPIRIT INSPIRES US TO
CONSTANTLY CHALLENGE THE CONVENTIONS OF
FINE WATCHMAKING.



ROYAL OAK
CONCEPT
SUPERSONNERIE
IN TITANIUM

AUDEMARS PIGUET
Le Brassus

AUDEMARS PIGUET UK LTD
TEL: +44 (0) 207 409 0782
AUDEMARSPIGUET.COM





TAGHeuer
C O N N E C T E D

#connectedtoeternity

www.tagheuer.com

BLACK BAY BRONZE

BRONZE CASE
DIAMETER 43 MM
WATERPROOF TO 200 M (660 FT)
IN-HOUSE MOVEMENT

Aluminium bronze alloy case. An aesthetic reference to historic ships and other diving equipment, this metal guarantees the development of a subtle and unique patina to match its user's habits.



TUDOR in-house movement MT5601. Offering a 70-hour power reserve and regulated by a variable inertia oscillator with silicon balance spring, it is certified by the Swiss Official Chronometer Testing Institute (COSC).

#TUDORWATCH
TUDORWATCH.COM



TUDOR

CONTENTS

HUBLOT MP-07
With its time and an impressive 42-day power readout squeezed around a set of upright cogs, the one-off MP-07 isn't for the mechanically shy. Nine mainsprings keep things ticking along. \$276,000
hublot.com

- 08 POWER RESERVES
- 12 INNER WORKINGS
- 15 CLOSE-UP: PARMIGIANI FLEURIER
- 16 FETISH
- 22 TEST: PREMIUM SMARTWATCHES
- 24 TRANSPARENT TIME
- 30 EXPERT PANEL
- 39 SHOW REPORT 2016
- 44 ILLUMINATION
- 46 TEST: LUXURY SMARTWATCHES
- 48 CLOSE-UP: TAG HEUER

MASTHEAD

Editor **David Rowan**
Supplement editor **Jeremy White**
Creative director **Andrew Diprose**
Managing editor **Duncan Baizley**
Deputy creative director **Ben Fraser**
Picture editor **Steve Peck**
Chief sub-editor **Mike Dent**
Deputy chief sub-editor **Simon Ward**
App producer **Pip Pell**
App designer **Ciaran Christopher**

Contributors **Andy Barter, Alex Doak, Chris Hall, Wilson Hennessy, Chris Hoare, Stephen Lenthall, Laura McCredie, Kathryn Nave, Mitch Payne, Josh Sims, Keith W Strandberg**

Commercial director **Nick Sargent**
Associate publisher & head of advertising **Rachel Reidy**
Senior account manager **Elaine Saunders**
Account manager **Victoria Morris**
Head of partnerships & events **Claire Dobson**
Partnerships director **Max Mirams**
Partnerships manager **Silvia Weindling**

Production director **Sarah Jensen**
Commercial production manager **Xenia Dilnot**
Production controller **Alicia Shepherd**
Production and tablet co-ordinator **Skye Meelboom**
Commercial senior production controller **Louise Lawson**
Commercial and paper production controller **Martin MacMillan**

Advertising enquiries **020 7499 9080**
Supplement free with WIRED 06.16



TIME 2016

Published by The Condé Nast Publications Ltd, Vogue House, Hanover Square, London W1S 1JU (tel: 020 7499 9080). Colour origination by Altimage London. Printed in the UK by Wyndeham Roche Ltd. WIRED is distributed by Condé Nast & National Magazine Distributors Ltd (Comag), Tavistock Road, West Droyton, Middlesex UB7 7QE (tel: 01895 433600). The one-year (10 issues) full subscription rate to WIRED in the UK is £35, £48 to Europe or US, £58 to the rest of world. Order at www.magazineboutique.co.uk/wired/WI73 or call +44 (0)844 848 5202, Mon-Fri 8am-9.30pm, Sat 8am-4pm. Enquiries, change of address and orders payable to WIRED, Subscription Department, Lathkill St, Market Harborough, Leics LE16 9EF, United Kingdom. Change of address or other subscription queries; email wired@subscription.co.uk or call 0844 848 2851. Manage your subscription online 24 hrs a day at magazineboutique.co.uk/youraccount.

All rights reserved. Reproduction in whole or in part without written permission is strictly prohibited. All prices correct at time of going to press but are subject to change. WIRED cannot be responsible for unsolicited material. Copyright © 2016 THE CONDÉ NAST PUBLICATIONS LTD, Vogue House, Hanover Square, London W1S 1JU.

The paper used for this publication is based on renewable wood fibre. The wood these fibres are derived from is sourced from sustainably managed forests and controlled sources. The producing mills are EMAS registered and operate according to highest environmental and health and safety standards. This magazine is fully recyclable – please log on to www.recyclenow.com for your local recycling options for paper and board.

It seems that in every part of our lives, we are fighting for more power or to better manage the power we have – from topping up our phones to winding our mechanical watches.

A power reserve of 36-50 hours is the norm for many timepieces, and could be considered woefully insufficient in today's world. But watchmakers are rising to the challenge.

THE NEED FOR USABLE POWER RESERVE

If you only have one watch, keeping tabs on the power reserve isn't really an issue. Assuming that your watch is an automatic (which uses a rotor to wind the mechanism when you are moving throughout the day), you wear it all day, at night you take it off and put it on your nightstand, and you put it on the next day. This way, your watch is never going to wind down.

However, many people own and wear more than one mechanical watch; maybe you wear a sports watch for the weekend, a dress watch for nights out and an everyday watch or two for work. A wardrobe of timepieces that are worn depending on where their owner are going, what they are wearing and how they are feeling, is increasingly common.

So, when they put down one watch to wear another, most of the time that watch has run down and needs to be rewound and reset, which is either a minor inconvenience or a major pain, depending on how complicated the piece is. Resetting a perpetual calendar with a moonphase and a celestial sky display



POWER

POWER RESERVES

often takes a watchmaker to get it set up exactly right. Even a standard three-hand piece with a date display takes a few minutes to set exactly.

Yes, there are ways around this – you can put all your watches into a beautiful winder so they are always wound, for example – but if watchmakers just made the standard power reserve a little longer, the problem would be solved.



A. LANGE & SÖHNE
LANGE 31
Price £95,000
Size 45.9MM
Movement
 Calibre L034.1
alange-soehne.com

WHAT IS POWER RESERVE?

What manufacturers list as the power reserve is the usable power that a watch has before keeping accurate time is compromised. If a watch has a claimed 80 hours of power reserve, it probably has a further 20 per cent left in it when it hits that 80 hours. But the precision of the timepiece could be affected.

Think of a wind-up toy car – once fully wound, the car would fly across the floor, stopping when the stored energy was depleted.

Watches are similar. We wind the mainspring, and that stored energy runs the all the features of the watch, including the time display. But a watch can't let all that energy out in one go, so the movement harnesses and manages that power using gears, wheels and a turning balance wheel. Where a toy car might have a power reserve of under a minute, watches must make that energy last as long as possible. Any additional features and complications (date, tourbillon, minute repeater, perpetual calendar, moonphase, etc), all demand power and make managing the stored power more difficult.



JACOB & CO
QUENTIN 31
Price £900
Size 56mm
Movement
 JCBM04
jacobandco.com

The aim and the challenge for power reserves is to get the greatest number of hours without affecting the precision of timekeeping.

The rate of precision in a watch varies by changes in the force from the mainspring. For the most part, energy release is constant, but as a watch winds down to almost stopping, timekeeping can become unreliable.

WAYS TO INCREASE POWER RESERVE

There are options for boosting power reserve. **Bigger barrels:** if you increase the size of the barrel and the length of the mainspring, you can store more energy. This, however, results in a larger watch.

More barrels: you can use multiple barrels (some watches use as many as 11, though two barrels are much more common), linking them so that the watch has a longer power reserve. Again, this requires more space.

Lower frequency: if you reduce the frequency, the energy demand on the spring is lower, making the stored energy go further. The most common modern automatic movement frequency is 4Hz or 28,800 revolutions per hour. A general rule is that the higher the frequency, the higher the precision. So, if you lower the frequency, precision can suffer.

New materials and technologies: the exact makeup of a mainspring is a closely guarded secret in the watch industry, and only a handful of manufactures can fabricate them. Watchmakers have been experimenting with

UPS

HOW WATCHMAKERS ARE PUSHING THE LIMITS OF POWER RESERVE

BY KEITH W STRANDBERG

PHOTOGRAPHY: STEPHEN LENTHALL

POWER RESERVES



**VACHERON
CONSTANTIN
14-DAY**

Price £200,000

Size 42mm

Movement

Caliber 2260

vacheron-constantin.com



**JAEGER
LECOULTRE
GRAND
TRADITION**

Price £90k

Size 42mm

Movement 995

automatic

jaeger-lecoultre.com

the alloys and materials used in mainsprings for centuries. But despite the innovations, broadly, the gains realised are only incremental.

Yet blasting past such technical limitations is Parmigiani Fleurier – its concept watch, the Senfine (which means “endlessly” in Esperanto), shown in January of this year, is aiming to achieve an astonishing *100 days* of power reserve (see p15). The Senfine uses a new regulating organ (with all parts manufactured in silicium), aiming to eliminate friction at all points of the energy consumption process.

EMPOWERING THE MASSES

Companies have introduced longer-lasting power reserves across their lineups. Hamilton, for example, has several watches capable of 80 hours; Glashütte Original has just introduced a new movement with 100 hours of power reserve. These achievements are even found in their entry level timepieces, changing the expectations of consumers.

At the higher end, several watchmakers have introduced serial production watches with seven to 15 days of power reserve (Ulysse Nardin – seven days; H. Moser – seven days; Officine Panerai (*main image*) – ten days; Vacheron Constantin – 14 days; Jaeger-LeCoultre – 15 days. Some bold outliers such as A. Lange & Söhne (the Lange 31 has 31 days

**H. MOSER &
CO ENDEVOUR
PERPETUAL
CALENDAR**

Price £36,000

Size 40.8mm

Movement

Caliber HMC 341

h-moser.com



of power reserve), Jacob & Co (the Quenttin has 31 days) and Hublot (with La Ferrari's 50 days) are pushing power reserve to extremes.

Add to that the Senfine's established goal of 100 days, and you are left with watches that only need to be wound a few times a year.

The length of power reserves being attained today is indeed technically exciting, though in truth possibly unnecessary. As one watchmaker said to WIRED, “If you have a watch for which you need 100 days of power reserve, meaning that you only want to wear it every 100 days, perhaps you shouldn't buy that watch.”

These developments will hopefully trickle down to regular collection watches, which is good news for watch lovers everywhere.



**OFFICINE
PANERAI
LUMINOR 1950**

Price £10,500

Size 44mm

Movement

P.2003

panerai.com





ASTRON



GPS
SOLAR

ASTRON. THE WORLD'S FIRST GPS SOLAR WATCH.

As Novak Djokovic travels the world, his Astron GPS Solar keeps him on time, adjusting automatically to his time zone at the touch of a button and using just the power of light. With dual-time display, Astron is simply the world's finest GPS Solar watch.



NOVAK DJOKOVIC

*If there are changes in the region / time zone, manual time zone selection may be required.

SEIKO

RESSENCE 5 EXPLODED

INNER WORKINGS

LIQUIDS AND MAGNETISM DON'T USUALLY MAKE FOR A SUCCESSFUL TIMEPIECE
— BUT THE RESSENCE TYPE 5 TAKES FULL ADVANTAGE OF THEIR UNIQUE ABILITIES

If there is one complaint to level at the Swiss watch industry, it is its reticence to embrace radical new thinking, either mechanical or aesthetic. It can sometimes take new upstarts to rock the boat – and perhaps none more so than Ressence, a Belgian company founded by Benoît Mintiens. Crucially, he is no watchmaker, but an industrial designer who has created vacuum cleaners for LG, pushchairs for Maxi-Cosi, interiors for Air France first class and even elements of the new generation TGV. For Mintiens, a watch is all about functionality, legibility and the expression of time, which, he notes, need not be the usual hands swinging around a centre point. “In fact, the very way we’re taught to read the time, by a series of hands, isn’t – from a designer’s point of view – the best way. Yes, such a graphic device is better than digital, because it can be read much faster. But it has to be explained and it’s not intuitive – only when it’s learned does it become the best way,” says Mintiens. “Yet we have it because watchmakers found a mechanism for measuring time and then, precisely what an engineer would do, just stuck some hands on it to give a read-out. But, in some respects, industrial designers build from the outside to the inside.” With this in mind, the new Type 5 is the purest expression of Ressence’s radical design agenda to date.

BY JOSH SIMS

Because oil and the glass have a similar refractive index, the two substances seem to appear as one. This eliminates perception of depth, so the watch indicators look as though they are on the dome’s surface.



2. DIAL

The Orbital Convex System features hours, seconds and an oil gauge rotating within a larger disc that gives the minutes reading. This method uses the minutes mechanism as the base calculation of time; the sub-dials take their cue from this.

3. MAGNETS

Timekeeping is transmitted from the dry mechanical compartment in the base of the watch to the oil-filled top two-thirds via magnetism. Micro-magnets sit on a titanium plate, connecting the movement below to these oil-suspended wheels and the dial indicators.

CROWNLESS CONTROL

To enhance water-resistance, the watch is wound and set via a rotating bezel on the case back.



1. GLASS

Light refraction typically means a watch face can only be viewed clearly from certain angles – and in the water they can look like mirrors. Under this glass is an oil-filled compartment which eliminates light refraction entirely, making the time read-out supremely legible.

4. BELLOWS

Seven nickel-and-gold bellows compensate for oil-volume changes due to temperature: they compress when the oil warms and its volume goes up, and expand when it's colder and the oil volume decreases. This is regulated by a bi-metal thermometer (the grey spiral above the magnets).

5. CASE

What better for a diving watch than to take inspiration from an amphibious animal? The Type 5's lightweight titanium case is curved like a turtle's shell, giving not only an aqua-dynamic shape, but a piece that sits more comfortably on the wrist.

RAYMOND WEIL

GENEVE



© 2016 Apple Corps Ltd. A Beatles™ product. - Photo by Bruce McBroom

CELEBRATING
**THE
BEATLES**

Join the discussion #RWTheBeatles



Limited Edition - **maestro**

raymond-weil.com tel: 01428 656 822

PARMIGIANI FLEURIER SENFINE

AEROSPACE TECH HELPS TO GIVE THIS MOVEMENT A SUPERIOR POWER RESERVE

Naming a new product after a word of Esperanto might seem a questionable marketing decision. But when Parmigiani Fleurier came to give a moniker to this groundbreaking design, it went ahead and called it the Senfine – Esperanto for “endlessly” – anyway. As it turns out, what sounds like a rather chichi watch is actually a piece of technology to go inside a watch, with a production model scheduled for 2018. And, for Parmigiani, a respected if somewhat marginal brand that turns 20 years old this year, it could prove a game changer in terms of the way it’s regarded within the watch industry.

Watchmaking is all about friction. It is the grind of mechanical part on mechanical part that the design of any movement has always sought to minimise, be that through the use of tiny gemstones to act as bearings or the requirement for careful lubrication. It’s the need to top this up that prompts the recommendation for watches to undergo regular, and often expensive, servicing. Grind, after all, is the enemy of precision.

A decade in development, the Senfine has taken another step towards solving this. Picture the interaction of a few key parts in a movement: the oscillator vibrates, losing energy as it does; this then affects the escapement (which provides the movement’s energy in regular bursts) every time it interacts with the balance; and then the pallet fork – which engages and disengages with the escapement wheel, like a brake being applied, let off, then applied again, over and over – loses yet more energy with each contact.

Since drastically reducing friction remains the watchmaker’s ultimate goal, an obvious step is to eliminate any unnecessary expenditure of energy within the watch’s regulator. The Senfine does this by taking several of the normally interacting parts and replacing them with a single, suspended system of frictionless joints made of silicon. The upshot is a mechanical watch with a power reserve measured not in the usual few days, but in weeks.

The Senfine is the brainchild of Pierre Genequand, a spatial



Digital extra!
Download the
TIME app to view
the movement

engineering technologist who never even trained as a watchmaker. Genequand has spent most of his retirement finessing the idea, lifting its basis from the aerospace industry and retrofitting it for watches. It makes sense: after all, who, trained in the traditions Swiss watchmaking holds so dear, would come up with an invention that would do away with ticking, as the Senfine has? It’s a brave new watchmaking world indeed.

BY JOSH SIMS

**OMEGA
SEAMASTER
PLANET OCEAN
CO-AXIAL
MASTER
CHRONOMETER**

Resplendent with a splash of orange, this new titanium 43.5mm piece's 8900 movement affords it magnetic resistance up to 15,000 gauss and has a 60-hour power reserve.

A partially rubberised bezel, with grey silicon nitride rubber blended with ceramic, joins with Liquidmetal for the orange minute-scale. In a first for the watch industry, the rubber lining is vulcanised at two different temperatures to lock zinc into the material.

£4,330 omega-watches.com

The locked-in zinc gives the strap's lining antibacterial and antifungal properties

SUPER STRAPS

BY JEREMY WHITE

FETTERISH

PHOTOGRAPHY: WILSON HENNESSY

Future proofing

The Caliber 2460WT movement is set up in such a way that if time zones change, it is easy for a watchmaker to swap the 37-toothed world time wheel with a new one and replace the dial

**VACHERON
CONSTANTIN
OVERSEAS
WORLD TIME
7700V**

The Overseas World Time includes no fewer than 37 time zones. Its display features a "Lambert" projection map depicting continents and oceans, along with a translucent disc bearing city names. The Caliber 2460WT movement operates at 28,800 vibrations per hour and boasts a 40-hour power reserve. WIRED loves the flexibility of the easy-fit bracelet system, which means straps can be switched without fuss (*see below*). £28,000 vacheron-constantin.com



Digital extra!
Download the TIME app to see the World Time's strap system



**AUDEMARS
PIGUET ROYAL
OAK DOUBLE
BALANCE WHEEL
OPENWORKED**

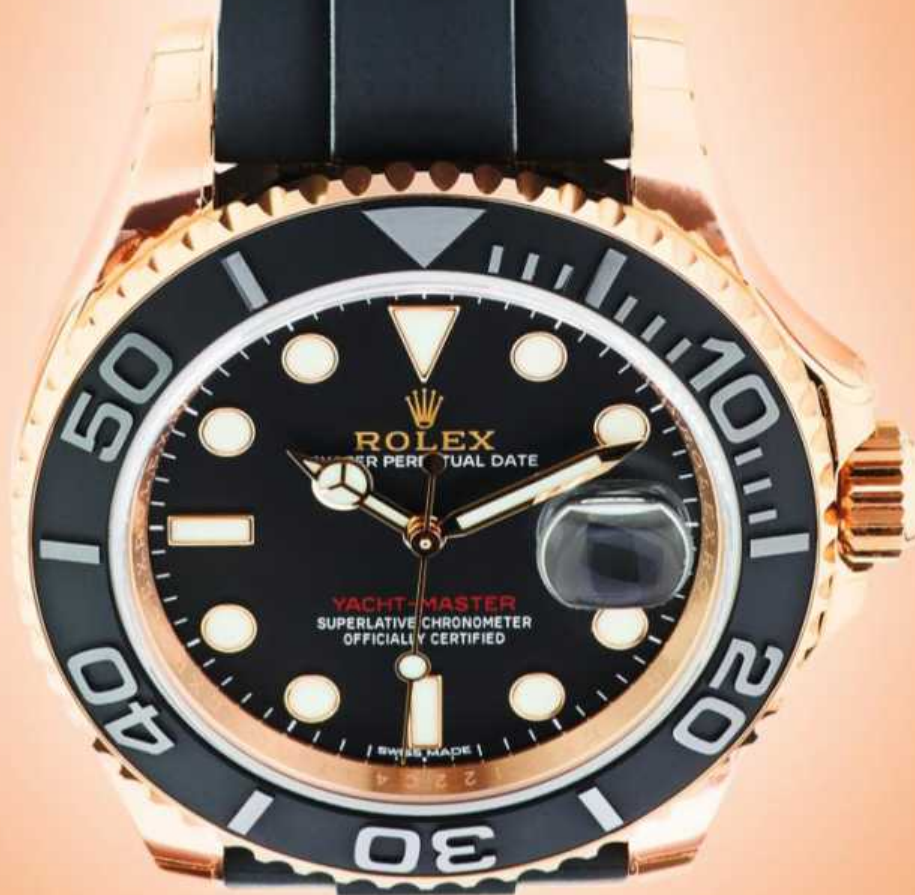
The 41mm Royal Oak has a new double-balance wheel escapement – which is a watch-world first. Having two balance wheels creates an oscillator with a greater mass, meaning greater precision and stability, and due to their placement on the same axis they self-regulate. The 45-hour power reserve is sufficient and the timepiece is available in stainless steel and rose gold. Each of the strap's tapered links are arranged in decreasing order of size. £32,200 audemarspiguet.com

All of the main and intermediate links are drilled, machined, polished and tested by hand

SUPER STRAPS



Flanges on the underside of the Yacht-Master ensure a stable fit on the wrist



ROLEX YACHT-MASTER 40

With 100-metre water resistance, a bidirectional bezel and dial, and hands that echo the Submariner, the uncluttered Yacht-Master is an elegant piece. Its middle case is crafted from a solid block of corrosion-resistant 904L steel and the patented Rolex Everose gold is offset by a rubber-like "high performance elastomer" strap called the Oysterflex bracelet. Within the material is a flexible titanium and nickel alloy metal blade which makes the Oysterflex more durable than other rubber straps.

£16,650 rolex.com

**BELL & ROSS
BR-X1
HYPERSTELLAR**

This 45mm grade 5 titanium skeleton watch is equipped with a 56-jewel automatic 30-minute chronograph movement and large rocker push-buttons designed to work when wearing a space suit. As befits a timepiece made for space travel, it's resistant to corrosion, impact, acceleration, high pressure, vibrations and water (to 100m). Bell & Ross has opted for a bi-material strap of alligator leather and grey rubber for durability and comfort. Limited to 250 pieces. £14,000 bellross.com

SUPER STRAPS

The strap is finished with a steel buckle with a robust overmoulded rubber insert





REGATTA
OTUSA

AMERICA'S CUP. BRITISH TIMEKEEPING.

Bremont has been appointed the Official Timing Partner of the 35th America's Cup and of the defending champions, ORACLE TEAM USA. To celebrate, we've created a collection of limited edition timepieces. The Regatta Series, specially designed to be used by sailors, incorporates a unique countdown chronograph movement. The Regatta OTUSA models even feature high-grade carbon fibre from the winning 2013 ORACLE TEAM USA AC72 yacht. So the question is, which of these fine watches should you choose? Sorry, you're on your own.



BREMONT
OFFICIAL TIMING PARTNER



TIMEX METROPOLITAN+

With a grand total of six hands, the Metropolitan+ firmly eschews the smartwatch trend towards minimalist mass-appeal. Although the overall effect is reminiscent of a classic chronograph, placing a long step/distance counter hand on the same dial as the second hand feels like unnecessary clutter and makes the watch difficult to read. However, WIRED did appreciate the ability to switch between functions such as step count or distance display.

Despite its heft – the watch is 42mm across and 12mm thick – it's still comfortable to wear and the supplied silicone strap felt particularly nice to the touch. Sadly, the complexity of the interface runs alongside minimal functionality – there's no sleep tracking, automatic time-setting or activity alarms – making this less a smartwatch than an ordinary watch with a pedometer bolted on. The app too is exceedingly basic with limited analytics and no ability to share your data with other services. **5/10** £130 timex.co.uk

The Metropolitan+ is water resistant to 50m and uses INDIGLOW lighting



EMIE NEVO BALADE PARISIENNE

In addition to activity tracking, the Nevo also comes with notification alerts – a nice feature, but limited guidance meant it took a while to figure out what the different flashes mean. The companion app is still unrefined – “height” is misspelled as “hight”, and for some reason WIRED’s name was automatically set to “welcome”. For tracking, a lack of integration with other apps is a major flaw and limits its usefulness as part of a broader fitness plan. This could be addressed in future updates, however. Step progress is displayed by LEDs around the rim, preserving the face’s appealingly clean and modern design. The included leather strap felt slightly cheap, though. **4/10** \$170 en.emie.com



SIMPLE & SMART

ESCHEW THE FUTURISTIC INTERFACES AND MAKE YOUR FITNESS TRACKING A STRIPPED-BACK ANALOGUE EXPERIENCE

BY KATHRYN NAVE



MONDAINE HELVETICA 1

This smart version of Mondaine's classic Helvetica watch is easily the highest quality activity tracking analogue watch available – as you'd expect, given the price tag. It's available with a silicone strap (pictured) or a lovely thick leather one. Yet frustratingly, there isn't a quick-release mechanism for swapping between the two, making the leather option impractical if you're going to use it during exercise.

A date hand and world timer mode (a triple tap of the crown and the hands rearrange themselves) should satisfy fans of traditional watch features. But the smart aspect isn't playing a weak second fiddle. In addition to a well-designed overview and detailed breakdown of activity data, the *Motion X* app offers power-nap timing with a smart alarm to wake you gently during a light sleep phase. Sleep mode isn't automatic, and the watch is too bulky to be worn on the wrist in bed, but WIRED found it effective in under-the-pillow mode. **7/10** £600 mondaine.com

HOW WE TESTED

Each watch was tested for accuracy over the course of a day against the research-grade Yamax SW200 pedometer to assess their ability to discriminate steps from typical arm movements. The watches were worn for five days to assess influence on physical activity levels and accompanying apps were also reviewed for clarity and usefulness.

WEIGHT

Metropolitan+: 70g
Nevo: 65g
Helvetica 1: 80g
Activité Steel: 37g

WATER RESISTANCE

Metropolitan+: 50m
Nevo: 50m
Helvetica 1: 30m
Activité Steel: 50m

DIAMETER

Metropolitan+: 42mm
Nevo: 42mm
Helvetica 1: 44mm
Activité Steel: 36.3mm

SLEEP-TRACKING

Metropolitan+: No
Nevo: Yes
Helvetica 1: Yes
Activité Steel: Yes

ACTIVITY MEMORY

Metropolitan+: 7 days
Nevo: 1-10 days
Helvetica 1: 10-15 days
Activité Steel: 38 hours

SMART ALARM

Metropolitan+: No
Nevo: No
Helvetica 1: Yes
Activité Steel: No



WITHINGS ACTIVITÉ STEEL

The smallest and the smartest of the models on test, the Activité Steel automatically detects and records running, swimming or sleeping activity which, along with automatic time-setting, leaves the streamlined body entirely button-free. Although swim and sleep detection worked well, WIRED's running efforts didn't register as anything more than a stroll. On the minimalist – if a touch clinical – face, an emphasised step-counter places exercise goals centre stage. The accompanying *Health Mate* app is attractive and comprehensive, integrating with *Google Fit*, *Apple Health*, *Fitness Pal* and others. WIRED found the ability to count steps taken against calories consumed acted as compelling encouragement. **8/10** £140 withings.com

**HUBLOT BIG BANG UNICO SAPPHIRE**

The case middle, bezel and rear of Hublot's limited-edition Big Bang Unico Sapphire are cut from blocks of sapphire; the crown, screws and deployant buckle are made from titanium. Its transparent resin skeleton dial reveals the proprietary Unico HUB1242 movement. To seal the see-through deal, the watch's strap is also transparent – you can see the wearer's skin through it. It's also water resistant to 50 metres.

A CLEAR-CUT CASE OF STYLE

The arcane world of luxury watches is well known for regularly serving up “trends” that have only a passing attachment to reality. Well, 2016 has been no exception, prompting an unexpected vogue among ultra high-end manufacturers for timepieces cased not in steel, or gold, but in solid sapphire.

This kind of trend often elicits a certain degree of eye-rolling from traditionalists (here defined as anyone who considers being able to read the time from their watch a priority), and often bafflement from those less *au fait* with the whimsy displayed at the upper echelons of watchmaking. But before you place yourself in one of those two camps, consider this: if you accept – as we all must – that the mechanical watch is an anachronism, then why not have some fun poking around at the edges of the envelope?

Certainly, there is a market for it. The avant-garde of watchmaking – led by brands such as MB&F, De Bethune, Urwerk and Richard Mille – is keenly aware of a strong collector base that thrives on watches that look like they were cooked up in a basement by HR Giger, HG Wells and John DeLorean, and produced by an army of perfectionists. Predominantly Hong Kong- and Singapore-based, these are serious watch buyers, who care about the watchmaking as well as the aesthetic, and value the steampunk ethos of highly complicated modern watchmaking.

BY CHRIS HALL

Such demand has fuelled a rich vein of watchmaking, with some extremely imaginative approaches to the simple art of keeping time, and ever-more recondite materials and techniques.

In the late 2000s, a number of brands began to experiment with sapphire components within movements and non-standard crystals on the watch face. But the quantum leap belonged to Richard Mille. The brand – already known for making pared-back, skeletonised movements that put everything on show – had produced a split seconds chronograph tourbillon movement and wanted to showcase it in an attention-grabbing watch. At the SIHH fair in Geneva in 2012, it unveiled the RM 056: the first watch with a case made entirely from sapphire crystal. This year, a piece celebrating the brand’s

ten-year relationship with racing driver Felipe Massa was announced, alongside a pink sapphire ladies’ watch, the RM 07-02.

For years, sapphire has been the material of choice for a good-quality watch’s “glass” (and see-through caseback) and sapphire crystals in standard sizes are factory-machined by the thousand. But if you get creative with the shapes required, the process becomes a lot more artisanal – and the shapes employed by Richard Mille, Rebellion Timepieces, Hublot and MB&F, which this year released a sapphire-cased variant of its bulbous HM6, are far from standard.

Five-axis CNC machines, the workhorse of the modern watch factory, do the actual milling and grinding, but that doesn’t mean it is an easy process. Sapphire cannot be moulded, forged or cast; it must

MB&F HM6 SV
A crystal dome is housed in the HM6’s four corners; a flying tourbillon is in the central dome.



be milled from solid blocks, and with a hardness of nine on the Mohs scale (ultra-tough diamond is ten), it places a fair strain on the machinery, and that's before you start worrying about precision levels. As Richard Mille himself explains: "To use an analogy that fits the discussion - producing and working with sapphire is like walking on thin ice. One wrong move and you fall through the surface. Sapphire is incredibly tough to cut, grind and polish. But it is also brittle. The watch's curved front and bezels, together with the caseband, need to match each other within microns and with no irregularities. If they don't, you must throw it all away, as you cannot adjust anything." Reportedly, the construction of the first RM 056 also resulted in some highly expensive machinery being thrown away, such as the difficulty of machining the cases.

Even when everything goes to plan, it's still a painstaking process. During the prototyping of the HM6 SV, MB&F founder Maximilian Büsler admits that "eight sapphire plates were broken before we mastered the first one. Once the process is mastered, the failure rate drops to around 20 per cent, which is still very high compared to other materials. The grinding is achieved piece by piece, because the raw material varies due to the alignment of the crystals." A single case takes 350 hours to make; it's a similar story for Richard Mille, whose RM 056 cases take 1,000 hours to machine and polish. That's right: despite sapphire's hardness, it comes out of the CNC machine in need of polishing before it's ready for use. Only five will be made in a year.

Büsler describes the overall process as "a combination of CNC action and manual artisanship"; each HM6 SV case is delicately polished by hand. On top of such intensive labours, there is the time spent redesigning elements of the watch which would normally be produced in titanium.

**BELL &
ROSS BR-XI
TOURBILLON
SAPPHIRE**

This limited timepiece's case is cut out of nine blocks of sapphire and assembled with screws. It is also water resistant to 30 metres.



his hopefully explains why sapphire-cased watches have been the preserve of super-collectors and produced in extremely limited numbers. Until now, that is. In January 2016, Hublot released the Big Bang Unico Sapphire, a see-through version of its in-house chronograph, stating that it would be produced in a limited run of 500 pieces. (It also announced a much more limited run of sapphire-cased LaFerrari watches, whose rarity stems primarily from the

movement). The watch features an unchanged Unico movement, with the three case components milled from sapphire. A transparent resin is used for the hands and numerals to complete the effect.

Also entering the transparent fray is Bell & Ross, with a (very) limited run of the BR-X1 chronograph. In distinct contrast to Hublot's approach, the watches will carry a six-figure price tag and most likely number in the single digits.

Creating watches cased in solid sapphire is enormously impressive. But without at all wishing to minimise the efforts involved, with dedicated minds at the task, the technical hurdles of such an idea will always eventually be overcome. Investing so heavily in the process as to make production at scale possible (relative to what has gone before, at least), as Hublot is doing, is in many ways more arresting.

Hublot CEO Ricardo Guadalupe tells of the same woes as Büsser and Mille, bemoaning that "It took about 20 years of research to produce components made of sapphire... and the final step of polishing sometimes reveals minimal defects in the material, meaning the failure rate is quite high", but cites certain "processes that we keep confidential that allowed us to reduce the costs". In fact, Hublot has invested "several million Swiss Francs in machinery" to enable it to bring the milling and polishing processes in-house.

MB&F and Richard Mille (and, no doubt, all independent watch brands working with sapphire) use specialist external suppliers such as Sebal SA and Stettler Sapphire to create their cases. Guadalupe says Hublot did partner with an outside supplier to develop the current cases, but has now committed to making sapphire cases in-house for several watches.

Consequently, the Unico Sapphire retails at £40,900 – hardly small change, but Richard Mille's RM 056 was produced in a limited run of five pieces at a time (as were its successors) and sold for \$1.65 million (£1.17m) apiece.

According to Guadalupe, Hublot may well make even more than the 500 Unico watches: "What we want to do with sapphire is to be able to produce the largest quantity – up to 1,000 pieces." Nearly all of the original 500 are sold, he says.

That's still limited by Hublot's production standards – the brand makes about 40,000 watches a year – but to put it in context, H. Moser & Cie, which in 2015 produced a one-off Venturer Dual Time in sapphire, will only make around 1,000 watches in a year in total.

Hublot is also betting heavily on what has only ever been seen as an extremely niche proposal. But is it really so outlandish? The history of watchmaking is littered with examples that suggest not. When Audemars Piguet debuted the Royal

Oak in 1972, stainless steel was so difficult to machine that the idea of selling serious quantities of a steel watch was viewed as lunacy. (The exhibition prototypes of the Royal Oak were actually produced in white gold because Audemars Piguet couldn't finish the steel cases in time).

How times change. We've recently seen similar stories with the use of titanium, carbon fibre and ceramic. All began as esoteric concepts; now they're seen as standard products. Low-volume production is what we expect from indie brands such as MB&F. But a powerhouse like Hublot, part of luxury giant LVMH, throwing its weight behind sapphire casemaking is interesting to say the least. Maybe one day, a transparent watch will seem no more oddball than a steel one. Maybe.

TRANSPARENT TIME



RM 07-02 PINK LADY SAPPHIRE
Richard Mille's Pink Lady was inspired by the 1930s cocktail of the same name.

neomatik from NOMOS Glashütte—
a series of new watches with the next generation
automatic movement DUW 3001.

nomos-glashuette.com, nomos-store.com





NOMOS
GLASHÜTTE
neomatik

EXPERT PANEL

SPECIALIST WATCH TECHNOLOGY FOR EVERY SITUATION



BULLETPROOF



VICTORINOX I.N.O.X.

Price from £379

Size 43mm

Movement

Ronda 715

victorinoxwatches.com



RALF TECH WRX HYBRID BLACK O

Price €1,800

Size 47.5MM

Movement

RTH002. ralftech.com

It used to be that you had to be careful when wearing an expensive watch, but today's luxury sports watches are built to handle just about anything you can throw at them. They go through a battery of tests, often to the point of destruction, just so you can be certain it will perform flawlessly on your wrist.

For example, in 2014, Victorinox Swiss Army introduced the I.N.O.X. collection, with watches put through gruelling tests including being run over by a tank, dropped off buildings, put into the washing machine on a two-hour cycle and more, all with the goal of producing the toughest timepieces on the market.

"We wanted a product that could resist anything," explains François Nunez, product and creative director, Victorinox Swiss Army. "There is no secret - we just did the testing, readjusted, tested again and repeated. We went through over 500 different stages and samples. We destroyed so many watches." At £379-£479, depending on the strap, it's also excellent value.

Bremont takes this even further, with some of their watches tested on Martin-Baker ejection seats. The watch is strapped on to the seat and then actually shot out of the cockpit, all to make sure their watches will keep on ticking.

"With the new F35 seat testing programme from Martin-Baker, we piggybacked on a lot of those tests as they are so phenomenally expensive to do," says Nick English, co-founder of the Bremont Watch Company. "Our new MBII [£3,595] can withstand just about anything. When you see the footage of the crash and vibration testing, it clearly proves that you can use these watches in any environment."

Ralf Tech is a relatively new watch company founded by Frank Huyghe, with the goal to design and produce the best possible dive watch. A dive industry supplier, Huyghe segued into watches in 2007. He used the French equivalent of the UK Special Forces to test his prototypes, eventually implementing the changes and ideas they had into his production model.

The result is the €1,800 WRX Hybrid Black "O", a 300-piece limited edition which is water resistant to 1,000 metres.

"We have several thousand Special Forces soldiers testing our watches around the world," says Huyghe of his firm's rigorous methodology. "There is no better test than a soldier falling from a plane at 8,000 metres, doing a free jump for 7,000 metres and landing in the water. You can do anything you want in the lab, but it won't be as real."

BY KEITH W STRANDBERG

BREMONT
MBII-WH
Price £3,595
Size 43mm
Movement
BE-36AE
bremont.com

PATEK PHILIPPE
REF. 4947G
Price \$49,900
Size 38mm
Movement
324 S QA LU
patek.com

2.



CARTIER
ROTONDE
Price \$94,000
Size 30mm
Movement
9912 MC
cartier.com



CHANEL
J12 FLYING
TOURBILLON
Price £900
Size 38mm
Movement
APRP SA
chanel.com

WOMEN'S

F

or all the hype they receive, you'd think complicated watches for women were a new invention, yet Patek Philippe launched a women's minute repeater in 1916. The first women's chronograph, Gallet's MultiChron Petite, was designed in 1939, for enlisted women assigned to technical and scientific tasks during WW2, who needed a timing device, but didn't want to wear a man's watch. Gallet's piece was 26.3mm in diameter and remains among the smallest mechanical chronographs.

But then complications on watches became the preserve of gentlemen. It's only recently that the Swiss watch industry has revisited this territory for its female clientele.

Patek Philippe continues to lead the field for those who like their complications understated, as the Annual Calendar Ref. 4947G (\$49,900, *left*) illustrates. There is a real assured femininity to Patek's design, as you'd expect considering how long it has been in the business. The day and month indicators at ten and two o'clock respectively deal with the practical aspect. The moonphase at six o'clock, and the diamonds around the bezel, lean toward the romantic.

Definitely more on the romantic side of the spectrum is Cartier's Rotonde de Cartier Day/Night Retrograde Moon watch (\$94,000).

In essence this is a straightforward moonphase indicator. However, where usually the monthly waxing and waning of the Moon is revealed in increments in a sub dial, this shows both the phases of the Moon in their entirety at the bottom of the dial, and the diurnal passage of the Sun and Moon above. Its usefulness is questionable, but it certainly is beautiful.

Also firmly in that category is Chanel's J12 Skeleton Open-worked Flying Tourbillon. In what feels like no time at all, Chanel has gone from a fashion house that dabbled in watches to a haute horlogerie big hitter.

Once again it has worked with technical powerhouse Renaud et Papi on its flying tourbillon with gem-set cage which, in a move that is becoming a signature, has been concealed underneath an iconic comet motif.

BY LAURA MCCREDDIE

Time keeper.



stop2go

2 SECONDS TO REMEMBER.

As the clock seen on all Swiss railway stations, the Mondaine stop2go Official Swiss Railways Watch runs a little fast for 58 seconds, then stops for 2 seconds at the full minute. Mondaine 58-02 Quartz Movement, Stainless Steel Case, Sapphire Crystal, Water Resistant, individually numbered, Swiss Made – what do 2 seconds mean to you?

Unmistakable face. Distinctive hands. Undeniably Swiss. The renowned Official Swiss Railways Clock skilfully reproduced as a watch.

Available at selected watch specialists nationwide.
For an illustrated catalogue and details of your nearest stockist telephone
0116 234 4656 or email info@bml-watches.com



www.mondaine.com



Facebook.com/MondaineUK

MondaineUK

MondaineUK

MONDAINE

Swiss  Watch

D

DIVING

iving watches are a staple of most Swiss-watch brands, regardless of whether they ever see more than a stray splash from the poolside. This year's models look both forward, with new materials, and backward, with updates of much-loved classics. The special edition of Oris's Divers Sixty-Five of 2015, itself a reissue of a 60s model, falls into this latter category. The CHF 2,600 Carl Brashear (*right*) is named after the US Navy's first black master diver. The unusual, seemingly quaint choice of bronze as the main material for the case is a nod to the helmets and weights used by deep-sea divers of yore. But there is more to it than that: bronze is not as hard as steel, but it is more plastic, it is anti-magnetic, does not create glare and won't corrode in salt water. It will also develop a unique patina as it oxidises over time. Sometimes the old ideas are still the best.

The Citizen Promaster Diver features all of the technical benefits of much more expensive models. The one-way rotating bezel, screw-down crown, anti-reflective crystal, diamond-like carbon-coated case and helium release valve are all present and, at £179, it's a fraction of the price of its showier rivals. All of which makes this a dive watch for use – right down to 300m below – rather than just a pricey prop for macho posturing. A bonus is the inclusion of Citizen's Eco-Drive solar tech – meaning that its quartz movement doesn't require a battery.

Being a design classic need not mean a watch lacks distinction. The Tudor Pelagos Blue (£3,020) is highly technical, made of a feather-like but super-strong titanium, and also sports a coloured ceramic bezel to match its striking dial. It is also one of the first watches to house Tudor's new proprietary movement, the MT5621 and, thanks to its bold colour, matte finish, minimalist aesthetic and highly legible "snowflake" hands, it's also a real looker. The bracelet's folding clasp with integrated extension (to adapt to a wet-suit's changing thickness under pressure) alone is a masterclass in small-scale engineering.

**CITIZEN
PROMASTER**
Price £179
Size 41mm
Movement
Eco-Drive E168
citizenwatch.com



**TUDOR
PELAGOS BLUE**
Price £3,020
Size 42mm
Movement
MT5621
tudorwatch.com



**ORIS DIVERS
SIXTY-FIVE**
Price CHF 2,600
Size 42mm
Movement
Oris 733
oris.ch



3.



TOUGH. RESISTANT. RELIABLE.

G-SHOCK
LANDSERIES



GWG-1000 MUDMASTER.

Available at **GOLDSMITHS**
SINCE 1778

G-SHOCK.co.uk

A

finely made timepiece is, in a nice twist of irony, an anachronism. Still driven by 200-year-old technological principles of cogs, springs and flywheels, it keeps worse time than the plastic digital that fell out of your cereal packet this morning. So, rather than reinventing said wheels, Switzerland's tweezer-wielders are keeping their time machines Alpine-fresh by tinkering with the packaging. By switching up from the usual steel or gold to high-tech, lightweight materials, a watch's case is becoming the most innovative part of the piece as a whole. Materials scientists are the watch industry's newest recruits.

4.

LIGHTWEIGHT



Carbon fibre leads the super-light revolution, as pioneered by the likes of Richard Mille and Audemars Piguet. Not only does its shiny black weave look cool, but it reflects the technology underpinning two of watchmaking's favourite sporting partners: motor racing and yachting.

Increasingly, the smart money is on new, proprietary composites – often stemming from the most cutting-edge sector in materials innovation, aerospace. So, trust Breitling then to boast the latest, unveiled at this year's Basel watch fair: Breitlight. It's used on the new Avenger Hurricane (£6,450) – a 50mm beast of a 24-hour chronograph that wouldn't look out of place on Batman's utility belt, yet sits on your wrist as innocuously as a Swatch.

Like a Swatch, it's plastic, but plastic as you've never known it: a polymer composite spiked with carbon fibre, quite similar to that used for the Glock pistol. The upshot of which is that it's 3.3 times lighter than steel, yet almost impossible to dent, scratch or corrode.

Surprisingly, Marilyn Monroe's favourite jeweller, Harry Winston, has had a big-hitting featherweight material to its name for some years. Its "Zalium" metal alloy can be found encasing every watch launched under the "Project Z" umbrella. The latest, the Z10, has a double retrograde display, exposing its mechanism with suitably techy panache.

The lightweight trend isn't all at the top end. Aluminium is currently having something of a moment – in the automotive as well as the watch world. Look no further than the aforementioned Swatch, whose Irony collection – so-named for its use of metal rather than plastic – gains 29 new "XLITE" models this year (from £76). The cases fuse a tough aluminium carcass with bright plastic inserts and panels.

Smartwatches may be (temporarily) snatching all the attention from "proper" watches, but for now at least, proper watches are proving that the use of high-tech materials can keep them relevant in the 21st century, as well as "smart" in their own right.

BY ALEX DOAK



BREITLING AVENGER HURRICANE

Price £6,450

Size 50mm

Movement

Caliber B12

breitling.com



HARRY WINSTON Z10

Price £poa

Size 42.2mm

Movement

HW3305

harrywinston.com



SWATCH IRONY XLITE

Price from £76

Size 41mm-45mm

Movement

quartz

swatch.com


**DE BETHUNE
DB25**
Price CHF

150,000

Size 45mm

Movement

DB2547

debethune.ch

**IWC PILOT'S
WATCH
TIMEZONER**
Price £8,200

Size 45MM

Movement

Calibre 809760

iwc.com

5.



TIME TRAVEL


**MONTBLANC 4810
ORBIS TERRARUM**
Price €5,890

Size 43mm

Movement

Caliber MB 29.20

montblanc.com

Ever visited Nouméa? Planning to go? What about the unpopulated South Georgia and the South Sandwich Islands? Thought not. These remote locations dutifully fill the dial space between more useful time zones on many world timer watches. Well, no longer. Independent watch brand De Bethune – whose aesthetic can best be described as “*Star Trek* meets Mayfair members club” – has released a world timer focused on cities one is actually likely to visit. The (CHF 150,000) DB25 World Traveller’s second time zone is indicated by a gold and blue “micro-sphere” held in a channel around the dial, which rotates every 12 hours to indicate night or day.

If you’re not completely on board with the quirky flourish of the De Bethune, consider the £8,200 IWC Pilot’s Watch Timezoner Chronograph. Making use of a patent acquired from indie brand Vogard in 2014, it uses a rotating bezel to set your second time zone. Simply press it down, twist it to the desired city, and everything else falls into place. A differential gearing connects bezel and hands, and the watch also packs a flyback chronograph for good measure.

Combining a measure of both globetrotting glamour and quirky good looks is the Montblanc 4810 Orbis Terrarum (€5,890, *left*). It first surfaced in 2014 with an all-blue central section – and WIRED thought it looked bold back then. Now, with a vivid injection of daylight-appropriate colour on its world map (as seen from the North Pole), it really sings. The pusher at eight o’clock adjusts the world time ring in one-hour increments, and the gradient dial is split into two levels, with a uniform blue semicircle indicating night-time around the globe.

BY CHRIS HALL



SWISS + MADE



ESSENTIAL GEAR.

ANU Chronograph Series No. 4241; 45mm, IP black plated stainless steel case and caseback, with crown protection and blockable pushers, unidirectional ratcheting bezel, antireflective sapphire crystal, multi jewel Swiss quartz movement with 8+ year lithium battery, water resistant to 200 meters, signature PU strap and black PVD brushed steel loops, and Luminox self-powered illumination. Swiss Made.

www.facebook.com/luminox

www.luminox.com



Available at selected high quality retail stores throughout the UK. For further details visit www.luminox.com or contact **Burton McCall Ltd** tel: +44 (0) 116 234 4656 email: info@bml-watches.com

Activité Steel

Styled for life. **Built for health.**

Activity & Sleep Tracking Smartwatch



Get 15% off on www.withings.com until August 15th.

Use **WIRED15** coupon code.

Download Health Mate App



 **Withings®**
Inspire health



SHOW

REPORT

FROM CURVED QUARTZ MOVEMENTS TO USING SLICES OF SPACE ROCK,
WE BRING YOU THE HIGHLIGHTS FROM THE INTERNATIONAL WATCH FAIRS

2016

BY JEREMY WHITE



NEW ARRIVALS

SHOW REPORT 2016



CASIO G-SHOCK MR-G MRG G1000 HT

This limited edition (300 pieces) owes its case texture to the use of tsuiki - a metalworking technique where a sheet of titanium is meticulously hammered into shape. The MR-G also boasts a timekeeping system that receives both GPS signals and radio wave time-calibration signals. £4,900 g-shock.co.uk



**RAYMOND WEIL
FREELANCER
SKELETON**
raymond-weil.com
£1,895



**CARTIER CLÉ
DE CARTIER
SKELETON**
cartier.co.uk
£40,800



**ROLEX
COSMOGRAPH
DAYTONA**
rolex.co.uk
£7,950



**AUDEMARS
PIGUET ROYAL
OAK CONCEPT
SUPERSONNERIE**
audemarspiguet.com
\$597,400



**ROGER DUBUIS
EXCALIBUR
AUTOMATIC
SKELETON
CARBON**
rogerdubuis.com
CHF 59,500



**IWC PILOT'S
WATCH
TIMEZONER**
iwc.com
£8,200

Patek has combined two calibers to create the thinnest world-timer chronograph



**PATEK PHILIPPE
5930G
WORLD TIME**
patek.com
\$73,712



**TISSOT
SMART-TOUCH**
tissotwatches.com
£800



**BULOVA
CURV**
bulova.com
£649



CURV features the world's first curved quartz movement



Moritz Grossmann Atom & Tefnut Lady
Timepieces in 18ct Rose Gold

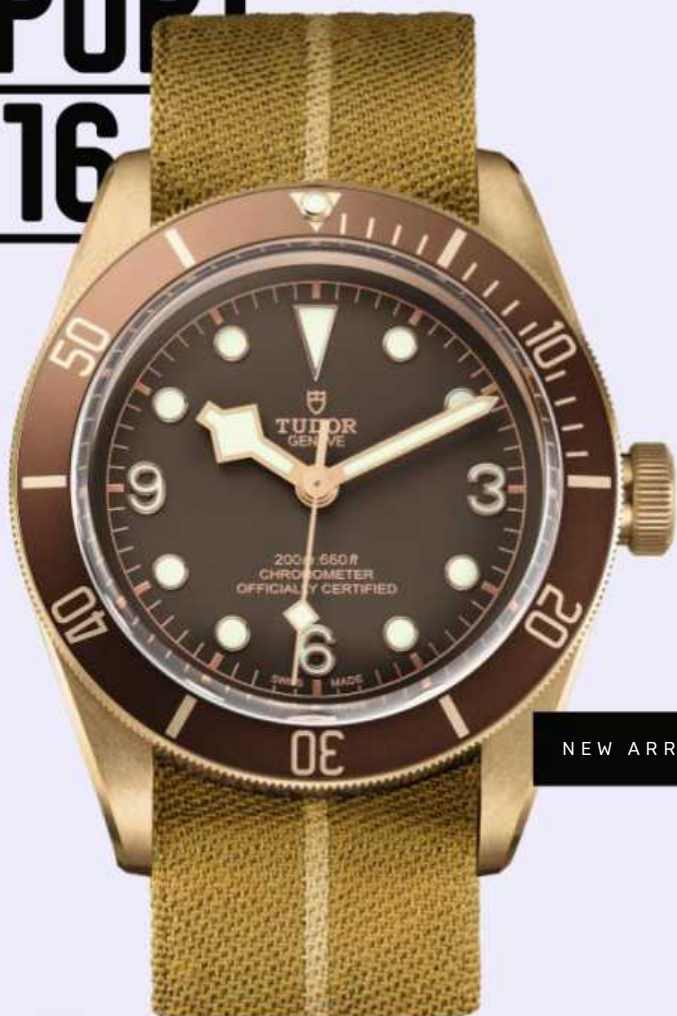


BY APPOINTMENT TO
HER MAJESTY THE QUEEN
GOLDSMITHS & SILVERSMITHS
WILLIAM & SON
LONDON

WILLIAM & SON

LONDON

SHOW REPORT 2016



NEW ARRIVALS

TUDOR HERITAGE BLACK BAY BRONZE

This 43mm bronze version of the Black Bay diver is waterproof to 200m. It's also the first piece to have Tudor's in-house MT5601 movement with a 70-hour power reserve. Bronze is an alloy of copper and tin, but here Tudor has added aluminium to regulate the patina that forms on the case. £2,730 tudorwatch.com



**TAG HEUER
MONZA
CHRONOGRAPH**
tagheuer.co.uk
£4,000



HUBLLOT MP-07
hublot.com
\$276,000



**JAQUET DROZ
GRANDE
SECONDE DUAL
TIME ONYX**
jaquet-droz.com
£13,200



**OMEGA
SPEEDMASTER
GREY SIDE
OF THE MOON**
omegawatches.com
£20,000



**GRAND SEIKO
BLACK CERAMIC
LIMITED EDITION**
grand-seiko.com
£10,000



**ZENITH HERITAGE
PILOT
CAFÉ RACER**
zenith-watches.com
£7,100



**ELLIOT BROWN
CANFORD WITH
RUBBER STRAP**
elliottbrown-watches.com
£375



**BREGUET
TRADITION DAME
7083**
breguet.com
\$38,900



**RADO
TRUE OPEN
HEART**
rado.com
£1,400

The dial uses slices of the Gibeon meteorite which reveal the rock's Widmanstätten crystalline structure

A LUXURY
TECH
SUPPLEMENT
**FREE
WITH
WIRED'S
DECEMBER
ISSUE**

OUT
NOVEMBER 3





ILLUMINATION

1.

GENERATING ELECTRICITY

HYT, known for its use of liquid as an indicator – as seen in previous issues of *TIME* – recently introduced the H4 Metropolis, which uses mechanically powered LEDs to illuminate the dial of the watch. A crown at four o'clock charges a second mainspring that powers a generator. When the button set into this crown is pushed, the dial lights up for five seconds. Only a few turns of the crown are needed. "In the watch, we have concealed two LEDs," explains Vincent Perriard, president and CEO of HYT. "Once activated, they flood the dial with blue light. At night, the green fluid is energised by this light source, becoming perfectly visible. The system is like a dynamo: converting mechanical power into light energy. We wanted to use a 'clean' technology – so no electronics and no battery."

OUT OF DARKNESS

MOMENTS OF BRILLIANCE IN THE ART OF ILLUMINATING MECHANICAL TIMEPIECES

BY KEITH W STRANDBERG

PHOTOGRAPHY: ANDY BARTER

2.

Since watches were introduced, their makers have been devising ways to make them usable at night. The first solution was the minute repeater developed in the 18th century – it allowed the user to activate a church-clock-like chiming to indicate what time it was in the middle of the night.

The next idea was a visual one, with the arrival of the glow-in-the-dark dial in the early 1900s. After a catastrophic start using a luminescent paint that killed a number of factory workers by radium poisoning, the watch industry now uses non-toxic SuperLumiNova paint. SuperLumiNova remains the standard in the industry, but its use is limited as it needs charging with a light source and then slowly fades over time, rarely lasting through 12 hours. Tritium tubes offer an alternative, but they are ever-so-slightly radioactive and not nearly as bright as SuperLumiNova when fully charged – though tritium does have a claimed 20 years of brightness.

Mechanical watchmakers like to maintain purely mechanical solutions when it comes to problem solving, and so two watch companies have recently come to market with innovative approaches to illumination.

PIEZOELECTRIC ILLUMINATION

Van Cleef & Arpels unveiled their latest development at SIHH this year: the still-in-the-prototype-stage Midnight Nuit Lumineuse, which uses piezoelectric ceramic to mechanically generate electricity. When

the pusher on the watch is activated, it deforms the ceramic, producing an electrical charge that powers LED lights under the diamond Monoceros constellation on the dial. It's an eye-catching solution, and is one that doesn't require using

an on-board battery. "A while ago, we started to look into ways to generate electricity within a mechanical wristwatch," says Denis Giguët, who was director of the watchmaking workshop at Van Cleef & Arpels during the Midnight's

development. "A beam made out of piezoelectric ceramic material is fixed on the movement on one side. The free side is bent back and forth by a cam, which turns at a specific speed when the pusher is activated. The vibration of the beam generates the electricity, which lights up the diamonds."



TESTED

BREITLING EXOSPACE B55

There are two distinctions to the Breitling Exospace B55. One, unusually for smartwatches, it puts your phone at the service of the watch, using its larger screen as a means of collating and displaying information gathered from the device. And two, it is arguably the first smartwatch designed for specialist use, in this case by professional pilots. WIRED's pilot's licence was delayed in the post (honest), so testing its more dedicated functions was tricky – but we're told that it allows commercial flyers to record and note such necessary data as time from taxiing to landing. Fortunately, the app allows this kind of functionality to be disabled – leaving the watch in “Sport” mode – because learning to operate a B55 probably comes more slowly than learning to fly a 747.

Without the benefit of its own touchscreen, all of the watch's functions are controlled using a conventional watch crown and pushers, which does not make its advanced functions out-of-the-box intuitive and caused WIRED to quickly crash the timepiece. Of course the same functions – time zones, alarms, night mode and so on – are much more easily set and reset from your smartphone, which is the point of this unconventional arrangement, even if the watch remains very much independent of your handset if you want it to be. And, with its handsome design, Super-Quartz movement, analogue and dual LCD screens and black titanium case, this is a striking and desirable piece. It's just that it's probably extremely useful to pilots, less so to everyone else. **6/10 (10/10 for pilots)**
£6,650 breitling.com



HOW WE TESTED

WIRED lived with these three watches for three days at a time, making a real-world assessment of their usability, wearability, comfort and functionality. It should be noted that, given the diversity of these particular “high-end” smartwatches, the scores should not be taken as the results of a head-to-head competition.

SMART

BLENDING TECHNOLOGY
WITH TRADITION,
PREMIUM SWISS WATCH
BRANDS ARE
BRINGING THEIR
REFINED APPROACH
TO CONNECTED
WEARABLES

BY JOSH SIMS

LUX



MONTBLANC TIMEWALKER URBAN SPEED E-STRAP

The problem with most smartwatches is that they are not so smart in style – a problem for those who still appreciate the elegance of a mechanical timepiece. This is where Montblanc's e-Strap – worn on the wristband of an otherwise conventional watch – finds its niche. Its tiny screen is less “touch” and more “pressure”, the script with which it announces events, emails, texts or calls is clear but miniscule, and it feels cheap and plasticky.

It does all that a smartwatch is any real use for: being an alternative interface for one's phone. Most of its utility is one way – from smartphone to wrist, though the Android/Apple-compatible device does allow remote camera and music app control. Its find-me function is handy when you misplace your phone – or, more worryingly, when you can't find your watch. But no, it's not fancy. There are no whizz-bang graphics or a megapixel display, but this gives it a supposed five days between charging (WIRED got three). True, it covers only the smart basics – but more importantly, it also allows you to keep wearing something with real style. **7/10** €350 (e-Strap only) montblanc.com

TAG HEUER CONNECTED



TAG Heuer's Connected is not a dainty watch – it has real presence, which is to say you'll need extra-roomy cuffs to wear it nicely. But it is arguably the best synthesis of traditional-watch feel and smartwatch functionality to date: think of the Apple Watch (albeit one running Android Wear) buried inside what looks to be an outsize, titanium, water-resistant sports watch emitting the curious glow of tomorrow. Like the Apple Watch, the Connected seems to need daily recharging, and it offers similar utility: the 1.5-inch circular LCD touchscreen reveals resident functions – fitness monitor, music, timer and so on, all operable away from your phone – as well as voice-activated Google and whatever apps you have on your Android phone.

The 4GB of memory, an Intel processor, Bluetooth and Wi-Fi means this has acceptable computing power for its package, but doesn't look particularly gadgety – more like the typical analogue watch of 2030, perhaps. There are flaws – the watch can be fitted to its magnetic charging cradle either way round, but only makes a connection the right way up; and for unknown reasons the first watch received for test just would not pair with WIRED's phone. But such teething issues aside, this is a neat hybrid. **8/10** £1,100 tagheuer.co.uk

It seems that since Jean-Claude Biver took the helm at TAG Heuer, he's been out to garner column inches. There was the hiring of model-of-the-moment Cara Delevingne, whose ambassadorship was announced at Paris Fashion Week and featured a real lion cub, then the launch of the brand's opinion-dividing smartwatch, and finally, the most democratic tourbillon on the

market today. The TAG Heuer Carrera Heuer-02T will retail at a relatively low £12,100, which will no doubt dent the cherished idea that this complication must cost a small fortune. "TAG Heuer has always been a Swiss avant-garde luxury watch brand with a high perceived value, but with an accessible price level," explains Jean-Claude Biver, the company's CEO. "Since we have built our own indus-

The Carrera Heuer-02T is made from Grade-5 titanium and has a 65-hour power reserve

trial dependency and now have the ability to produce any movement, watch case or dial, we thought it would be interesting to start building our own tourbillon movements."

In keeping with the TAG ethos that any watch it makes should have a perceived value of four times its retail price, it first decided that this watch's perceived value should be around £30,000 to £40,000. Which meant the team at TAG Heuer had to make a tourbillon for £7,000 to £10,000. No small challenge considering watches with this particular type of complication usually have six-figure price tags (TAG Heuer's own Carrera Mikro-tourbillon will set you back £175,000).

Although TAG Heuer hasn't exactly provided a balance sheet showing where the savings were made, it certainly didn't compromise on quality or materials.

Granted, there isn't the level of finishing you'd get with other complicated timepieces. But if all you want is the bragging rights of owning a tourbillon, this is the ideal addition to your watch collection.

As the name suggests, the case is based around the TAG Heuer Carrera Heuer 1 - the new modern-looking chronograph that the brand launched in 2015 to appeal to younger customers. It is made from Grade 5 titanium and has 100-metre water resistance.

The middle section of the tourbillon cage is made from titanium, and the top part is carbon fibre, which makes it very light and helps improve the performance of the power reserve. It runs at 28,800 vibrations per hour.

The movement has, as its basis, the CH-80 chronograph. The CH-80 was the all-new in-house movement project Jean-Claude Biver shut down when he took the helm at TAG Heuer. This is a modification of that original.

Looks like those column inches Biver's been garnering on TAG Heuer's behalf are wholly justified.

BY LAURA MCCREDDIE

CLOSE-UP #2



TAG HEUER CARRERA HEUER-02T

WIRED TAKES AN EYEGLASS TO THE SWISS BRAND'S TOURBILLON TIMEPIECE

WIRED

FOLLOW WIRED ON
INSTAGRAM

DAILY UPDATES FROM
THE WIRED TEAM

INSIDER ACCESS TO
WIRED STORIES

GO BEHIND THE
SCENES AT WIRED

@WIREDUK



PATEK PHILIPPE
GENEVE

Begin your own tradition.



You never actually own
a Patek Philippe.

You merely look after it for
the next generation.



Chronograph Ref. 5170G

Tel: +44 (0) 1753 891348
patek.com